THE TANJORE MAHARAJA SERFOJI'S SARASWATHI MAHAL.
2626
1784 2557

QUESTIONS AND ANSWERS

ON THE

PRACTICAL DUTIES

OF

Artillery.

2557

QUESTIONS AND ANSWERS

CHIEFLY ON THE

PRACTICAL DUTIES OF ARTILLERY,

COMPILED

FOR THE USE OF THE

Madras Artillery,

AND

FOR OFFICERS OF THE ARMY GENERALLY.

BY

J. H. FRITH, LIEUTENANT COLONEL,

DIRECTOR ARTILLERY DEPOT.

MADRAS:

PRINTED BY AUTHORITY OF GOVERNMENT

AT THE GOVERNMENT PRESS,

1831.

2557

The COMPILER of this Book in 1825, framed Questions and Answers on Artillery on a small scale for the use of the Madras Artillery Depôt of Instruction, of which he had recently been nominated Director, about 50 Copies were Lithographied.

A new edition having been called for, while in progress, and on a larger scale than the former, the Pocket Gunner reduced to a system of Questions and Answers published in 1828 at Dundee by Captain Duncan of the Royal Artillery, fell into the Compiler's hands, it professes to be taken entirely from the Pocket Gunner, and is recommended by Captain Duncan as a useful little work for Officers generally of the British Army, Cavalry and Infantry, which it undoubtedly is.

From this Work, and from the British and Pocket Gunners, much of this publication has been taken, and at the same time a considerable portion connected with the Ordnance in India, more particularly at Madras, will not be found in any other publication.

ARTILLERY.

PERSONNEL.

What do you understand by the word Artillery?

Artillery in a general sense signifies every thing connected with fire Arms and the Men by which they are worked, but it is not customary to class Musketry under the head of Artillery.

What do you call the Personnel of Artillery?

The Men by which pieces of Ordnance are manned and worked.

What do you call the Materiel of Artillery?

The different pieces of Ordnance, Stores, Ammunition and Machinery of every kind required for the use of Artillery.

What do you understand by the Regiment of Artillery?

The Military branch of the personnel of Artillery, that is, the Men who work and man pieces of Ordnance.

Into how many component parts is the Regiment of Artillery divided?

Into two grand divisions, Horse and Foot.

On what principle is the Regiment of Artillery formed?

On the same principle as the Army at large, divided into Brigades and Troops of Horse Artillery, and Battalion and Companies of Foot Artillery, and in every respect governed by the same rules as the Cavalry and Infantry.

What do you call a Brigade of Artillery?

This term is applied to the whole body of Horse Artillery, in the same manner, Battalion is to the Foot Artillery; and moreover 2 Guns are also called a Brigade.

This term being applied in both cases, leads to confusion, the divisions

of Troops and Companies should correspond with those of Cavalry and Infantry as nearly as possible.

WHAT do you call a Field Battery? — The Ordnance with which a Troop or, Company is armed.

FOR what purpose is Horse Artillery required? — For rapid movements, it should be able to keep up and manœuvre with Cavalry.

FOR what purpose is Foot Artillery required? — Foot Artillery when with Light Ordnance act with Infantry, and should be able at all times to manœuvre and keep up with it.

Foot Artillery also man heavy Field Artillery, the Battering Train and Garrison Ordnance.

ARE Horse Artillery men available for all general Artillery duties? — Yes, at Sieges, or, whenever required, the Horse Artillery are employed with every description of Ordnance, to which they are drilled in the same manner as Foot Artillery.

Is there any difference in the working of a Gun whether manned by Horse or Foot Artillery when in position? — No, when a Gun is once placed in position no matter by what means it was brought there, it is worked in the same manner whether manned by Horse or Foot Artillery.

How is a Troop or Company armed? — Both a Troop and Company is armed in the same manner; no Ordnance but Light are permanently attached to either.

How many Pieces of Ordnance has a Troop or, Company? — This differs in different services; in the British Artillery 5 Guns and 1 Howitzer, compose a Troop or, Company; at Madras 6 Guns in the Field and 4 in Cantonment are attached to a Troop of Horse Artillery, and 8 Guns in both cases, to a Company of Foot Artillery.

With what Calibre are Troops and Companies armed?	This also differs in different services, in the British Artillery light 12 pdrs. 9, 6, and 3 pdrs., light $5\frac{1}{2}$ Inch Howitzers, and lately 24 and 12 pdrs. Howitzers have been admitted into Field Batteries.
	At Madras the European Horse Artillery are armed with 9 pdrs the Native Horse Artillery European and Native Foot Artillery, with 6 pdrs.—no other description of Ordnance are permanently attached to Field Batteries.
Is it usual to mix Calibres in Field Batteries.	In the Royal Artillery one Howitzer is in each Battery, whatever the calibre of the Guns may be, in Bengal three different calibres were in use with each Field Battery.
Are there any disadvantages in thus mixing Calibres in the same Field Battery?	Yes, sometimes mistakes will happen by detaching Waggons with one kind of Ammunition with Guns of a different Calibre.
	It is much better to have complete Batteries of the different natures of Ordnance required than to mix them in one.
What is the best number of Ordnance for a Field Battery?	No Battery should consist of more than 8 Pieces, no man can conveniently command a greater number. This number can easily be divided into two Wings of 4 Guns each, and each Wing into 2 Guns each called a Division or Brigade.
	6 Pieces of which the British Artillery Field Batteries consist are not so easily divided for detachment.
Should a gun ever be detached by itself?	No, never less than two together in case of the accidental choking of

the vent, or other cause that might render it for the moment unserviceable, when the fire of the other would support it till prepared to recommence its fire.

Is it necessary the Horse Artillery should at all times manœuvre at a rapid pace?

By no means, the Horse Artillery should never gallop except in extreme cases when it may be necessary to occupy a position before the enemy can reach it.

A Troop in a gallop is no longer manageable, it is impossible any word of command can be heard and acted on, save the trumpet to halt.

WHAT is the proper pace for the Horse Artillery to manœuvre at?

At an easy trot, beyond that pace, the horses are not sufficiently in hand to conform to any sudden ordered formation, the pace should not exceed that of the slowest trotting horse in the Troop.

Galloping and dashing about only knocks up the horses and injures and destroys the Gun Carriages and Harness.

MATERIEL.

LIGHT ARTILLERY.

On what principles is Artillery attached to Armies?

Artillery is considered an Auxiliary to an Army, but an Auxiliary that cannot be dispensed with in the present state of warfare. The grand object of Artillery therefore is to adapt it to the purposes for which it may be required, and that it may be able to act and move with such celerity as not to clog or impede the movements of the Troops with which it is combined.

Into how many divisions may the Materiel of Artillery be divided?

Into five:

Horse Artillery,
Light Field Artillery,
Heavy Field Artillery,
Battering Train,
Garrison Ordnance.

The same pieces answer for the two latter, heavier metal is sometimes used in Garrisons than in the Battering Train, because it has not to be transported from place to place.

What is meant by Light Field Artillery?

All Light Ordnance that march and manœuvre with an Army, come under this denomination.

What is meant by Heavy Field Artillery?

Ordnance of a heavier calibre than Light Field Artillery, able to keep up with an Army but not exactly to manœuvre with it, or keep its place in the line of march, they usually march with the Park, are placed in position previous to a general engagement from which they are seldom moved.

WHAT is a Battering Train ?	Heavy Ordnance used to make breaches, in India the same pieces compose the Heavy Field Artillery.
WHAT is meant by Garrison Ordnance ?	Ordnance of every description used in the defence of Fortified Places.
WHAT are called Field Batteries ?	Field Batteries consist of any kind and number of Field Ordnance acting together, they should be sufficiently light to change position and conform to all the movements of the Troops with which they are acting.
WHAT is the object of a Field Battery ?	To cover the movements and support the Troops with which it acts.
SHOULD Field Batteries be independent or attached to Wings, Brigades, &c. of the Army ?	To have an efficient and well served Artillery, the whole should be under the Commanding Officer of Artillery, attached to wings of the Army and follow it on all occasions, or portions of it as ordered, but the Artillery duties, and responsibility should rest with the head of that line.
How should Field Batteries be placed in position ?	Field Batteries should occupy such positions in a line, that their cross-fire may cover the whole of the Troops between them, placed in intervals along the line, not in front or rear of the Troops, as in either case the shot of the enemy would have a double object. The flanks of a line should be guarded by guns in such a manner that they may be brought to bear on an enemy attempting to turn them.
How is a Field Battery masked, and for what purpose ?	By drawing up a body of Troops in front of it, Cavalry are generally used on this occasion, as they move quicker out of the way than Infantry. The object of masking a Battery is that the enemy may not know guns

are opposed to them till they are within a good range.

On the line of march where are the Field Batteries placed?

In the same intervals they are to occupy in line of battle, or, wherever they are most likely to be required, either in front, rear, or on the fighting flank.

When Troops are in squares to resist the charge of Cavalry, where should the Field Batteries be?

The guns should be placed outside at the angles of the squares, the limbers, horses, &c. inside; when the men are driven from the guns, they should retire into the square, bringing with them the sponges, and all the side arms; the moment the enemy have retired, rush out and recommence their fire; the guns should be discharged previous to their retiring.

When the Troops form a series of Regimental squares, called Waterloo squares, and the guns are between them, forming curtains as it were in the event of their being charged, and time, or the smallness of the squares not affording sufficient room for them, the waggons and limbers should be brought up with their broad sides to the front so as to occupy if possible the space between the guns, leaving no intervals for the Cavalry to cut through, the drag ropes would also offer an effectual momentary impediment to them, if properly stretched and secured, the men behind this barricade not actually required with the guns, would with their fuzils make a good fight.

When attacked in front and rear, each alternate gun should be faced different ways.

What proportion of Artillery is usually allowed to Armies?

This differs in different Services 6 guns to 1,000 men is the greatest proportion known, the usual number is from 2 to 4 guns per 1,000 men.

Of what kind of Artillery should the Reserve consist?

Of Horse Artillery, the object of the Reserve Artillery is to come into play at any part of the line where assistance may be required, and the more expeditious this can be done the better, and to seize any spot, that, from the movement of the Troops, may be advantageous, or prevent its being so to the enemy.

The Reserve should be composed of the best Artillery, and be at least equal to that in position or even double it.

Where should the Reserve of Artillery be placed?

In the rear with the second line, out of shot if possible, or, as little exposed as circumstances will admit.

Are heights advantageous for Field Batteries.

Advantage should be taken of any heights to place batteries on, but they should not be above 12 or 16 yards above the level of the plain, or, the shot will bury itself, instead of Ricochetting.

In firing at a line, how should the Artillery be directed?

The Guns should be brought to bear obliquely on it, because the shot will then destroy more men than when fired direct.

In firing at a column how should the Artillery be directed?

The direct fire is the best, as the shot will expend itself in a dense column, and do as much mischief as possible, whereas in a line of only two or three deep, it would not.

The shot should be directed at the head of a column.

At what distance

Round Shot from Field Batteries

should round Shot be fired? — cannot be depended on beyond 1,000 yards, although they will go much further.

In marching to the attack how should Artillery be used? — In marching to the attack the object of the Artillery should be that of the enemy's Artillery, to endeavour to silence their fire, that the Troops may suffer as little as possible as they advance, a smart Cannonade should be opened some time before the line advances, as the Guns cannot play while the Troops are actually moving, as they must advance with them.

In defence how should Artillery be used? — When on the defensive, the Guns should bear on the Enemy's Troops, and as much as possible on one point, to endeavour to break their line. In this case the firing at the adverse Artillery would have little or no effect for if all the Guns were silenced, it would not stop the line.

In passing a River, how should Artillery be used? — The Guns should be posted on the bank, to defend the Troops in passing it, a few pieces to pass with the line, to cover the formation on the opposite bank, if the River be very broad.

In defending the passage of a River, how should Artillery be used? — All the Guns should be brought to concentrate their fire on the point or points, where the enemy are attempting to force a passage.

In passing a defile, how should Artillery be used? — In passing a defile, it having been previously cleared, the Guns should precede the line, and form on the right and left of it, and open their fire on the enemy's Artillery, which in most cases will be more annoying than that of the Infantry.

In defending a defile, how should Artillery be used? — The Guns should be at some distance from it, clear of Musketry, and open their fire on the Mass of Troops

debouching from it, before they have time to form.

Previous to the line advancing to a charge, how should the Artillery be employed?

In firing at the Eenemy's line, and bringing all the Guns within range to bear on one particular part where it is intended to charge, making as it were a breach in the line; a certain number of men killed at one particular spot, would have more effect than double the number destroyed proportionally all down the line.

How ought heavy Guns to be posted in a defensive position?

In a defensive position heavy Guns should be posted in those points from which the Enemy can be discovered at the greatest distance and from whence may be seen the whole extent of his front.

How ought heavy Guns to be posted in an offensive position?

In an offensive position, the weakest points of the line, and those most distant from the Enemy must be supported by the heaviest Guns, those heights on which the Army in advancing may rest its flanks, and those from whence the Enemy may be fired upon obliquely, must be secured by those Guns.

What proportion of Guns should be attached to a division of the Army consisting of 12,000 men.

The proportion of Guns attached to an Army must depend on circumstances, but a moderate proportion will be three pieces of Ordnance for every 1,000 Firelocks, one-third of which should be in action, and the other two-thirds in reserve.

What nature of Guns should be employed?

This must depend on the nature of the country, and means of transport, but besides the above proportion of light Guns the Park of Artillery should always contain a proportion of Ordnance of a heavy Calibre, such as 18 pounders, 12 pounders, and $5\frac{1}{2}$ inch

Howitzers for forming batteries of position, defending intrenched posts, breaking down Bridges, and dislodging an enemy from temporary works.

WHAT proportion of Guns of a heavy Calibre should there always be in the Park?

There should be about one 18 pounder and one $5\frac{1}{2}$ inch Heavy Howitzer to each division of the Army.

WHAT other requisite should be always kept in reserve in a Park of Artillery?

The Park should likewise contain spare Carriages, Stores, and Ammunition for every description of Ordnance to be employed, also Pontoons or boat Equipages and moveable Magazines for the Cavalry and Infantry.

How should Guns generally be placed?

Guns should always be placed as much as possible under cover and this is easily accomplished upon heights by keeping them so far back that the muzzles only are seen, or, by placing them behind banks, ditches, &c.

WHAT is the most destructive fire?

A cross fire is the most destructive, and Guns should always if possible be arranged in such a manner as to produce a cross fire on the enemy's position, and upon all the ground he must cross over to attack you.

WHAT is the best method of concentrating a cross fire on any particular point?

In order to concentrate a cross fire on any particular point, the batteries should be subdivided ; thus the fire of the enemy will be attracted to different objects, whilst your own is directed to one point.

WHAT positions for Guns should be chosen.

In choosing positions for Guns those in rear of the line ought always to be avoided because they alarm the troops, and offer a double object to the fire of the enemy, those positions which are

not likely to be shifted ought to be preferred, and in this case a low breast work of 2 or 3 feet may be thrown up to cover the carriages.

WHAT may an Army in order of Battle be considered?

An Army in order of Battle may be considered as a front of fortification of which the lateral batteries are the bastions, and the infantry the curtain; and it is under the protecting fire of these batteries, that the troops manœuvre freely, and advance to the attack of the enemy.

GARRISON ARTILLERY.

How are fortified places generally divided?

Fortified places are divided into 8 Classes, viz. those capable of containing 12,000, 10,000, 8,000, 5,000, 2,500 1,600, and 400 men.

How are fortified places classed with respect to the number of Guns they contain?

Fortified places of the first class containing 12,000 men, ought to be furnished with 100 Guns, then 90, 80, 70, 60, 50, 40 and 30 pieces of Ordnance.

WHAT number of men is necessary to defend a hexagon?

As a general rule, it may be said that 4,200 infantry are necessary for a hexagon, susceptible of one attack only, and 150 men per front should be added for every side above six of the polygon.

IN classing Garrisons or fortified places as above what proportion should the different natures of Guns bear to each other?

In fortified places as above, one-third of the Guns should be 18 pounders, one-third 12 pounders; and one-third, 24, 9, and 4 pounders.

What quantity of Ammunition will be required for each piece of Ordnance?

If the place does not possess any very extraordinary means of defence 800 rounds per Gun will be sufficient for the two large Calibres and 900 rounds for each of the others.

What proportion of Spare Carriages should there be?

The proportion of spare Carriages should be one-third the number of Guns?

What proportion of Mortars should there be for the defence of a fortified place?

In the defence of the three first Classes of fortified places the number of Mortars should be in the proportion of one-fourth the number of Guns, and one-fifth or one-sixth in the other classes. Of these two-fifths will be 13 or 10 inch Mortars and the rest of a smaller nature.

What proportion of Howitzers should there be?

The number of Howitzers should be one-fourth the number of Mortars?

What proportion of Shells should there be for the Mortars and Howitzers?

There should be 100 Shells for each of the 13 and 10 inch Mortars and 600 for each of the smaller ones.

What quantity of Sand bags will be necessary for each piece of Ordnance?

It will be necessary to have 500 Sand bags for each piece of Ordnance in the large places and one-fourth less in the smaller ones.

What number of Musquets and Flints will be required?

It will be necessary to have one Musquet per Soldier and the same number to spare; also 50 Flints per Musquet.

What quantity of lead or Balls will it be necessary to have for the small Arms.

It will be necessary to have 30 lb. per Musquet; this allowing 14 Musquet Balls to the pound will amount to about 420 Balls per Musquet.

In what manner may the probable

The probable length of a siege may be estimated in the following

length of a siege be estimated ?

manner, viz. From the first investure to the opening of the Trenches 5 days ; from the opening of the Trenches to the effecting a lodgment on the glacis about 18 days, and from this time to the capitulation about 5 days more. The above method of calculating is particularly applied to a regular hexagon.

How ought the Artillery to be arranged in the defence of a regular hexagon ?

In the first period of the siege there will be 3 Guns on the barbette of each bastion, and on the barbette of the ravelins in front of the gateways half 24 and half 18 pounders and there will be also three 9 pounders on the barbette of each of the other ravelins.

What number of Guns must be in reserve ?

There must be twelve 12 pounders and twelve 4 pounders in reserve ; the former to be arranged behind the curtain on whatever side they may be required ; and the 4 pounders to be placed in the outworks, both to fire en ricochet over the parapet.

How ought the Mortars to be arranged ?

One 13 inch Mortar must be placed in each bastion and six of 8 inch in the salient angles of the covert way and as many more in reserve.

What is the next arrangement to be made with the Artillery ?

The day succeeding the night on which the Trenches are opened and when it is determined on what side the attack is to be made, all the 24 and 18 pdrs. must be removed to the front attack, and the other bastions if necessary must be supplied with smaller Ordnance.

How will all these different Guns be placed ?

Five Guns will be placed on the barbette of the bastions attacked and twelve 18 pounders may be ranged behind the curtain.

How will the Mortars be placed.

The six Mortars in reserve must be placed, two in each of the salient angles of the covert way of this front, to fire down the prolongations of the capitals.

How should the 9 and 4 pounders be placed ?

Five 9 pounders ought to be placed in the ravelin of the front attacked, and three 4 pounders on each of the salient places of arms of the ravelins for the purpose of firing over the palisades.

Will the above arrangement of the Artillery answer during the whole Siege ?

Yes ; for with a few exceptions no other dispositions will be required. at least during the second part of the Siege.

When the fire of the Enemy is properly established ought the Guns to be continued on the barbette Batteries ?

When the fire of the Enemy is properly established the Guns ought not to be continued in barbette for they would then be too much exposed ; embrazures must therefore be made for the Guns.

When the enemy gets near the third parallel how must the Artillery be then arranged ?

As the enemy advances to the third parallel the Guns must be withdrawn from the covert way to the ravelins, or to the ditch, if dry, and by degrees as the enemy advances, the Guns must be withdrawn to the body of the place.

What other arrangements of the Artillery must take place when the enemy has advanced as far as the third parallel ?

When the enemy has advanced as far as the third parallel the embrazures must be prepared in the flanks, in the curtain which joins them ; and in the faces of the bastions which flank the ditch of the front of the ravalins. These embrazures must be all ready to open, and the heavy Artillery mounted in them, the moment the enemy attempts a lodgment on the glacis.

What charge of Powder is used for the heavy Guns during the first and second periods of the Siege ?

During the first and second periods of the Siege the Guns are loaded with only one half the Service charge.

What charge of Powder is used during the third period of the Siege ?

During the third period of the Siege the Guns are charged with one-third the weight of the shot or the full Service charge.

What other steps must be taken by the Commandant when the enemy is advancing to attack it ?

After the Artillery has been arranged as above described, strong guards must be mounted on the different gates of the Town, and should the Commandant suspect the fidelity of the inhabitants, guards must be distributed about the Town and an interior police formed.

What other precautions are requisite to be taken when a place is attacked ?

Patroles of Cavalry supported by detachments of Infantry posted in advantageous situations must be sent out and the Cavalry must be pushed on as far as possible to harrass the enemy in every direction.

Ought the Artillery to commence firing at the very first moment of the Investure.

The Artillery ought not to commence firing at the very first moment of the investure because the fire from the Guns cannot be of great utility at this period of the Siege, and it tends to show the enemy the range of your Guns.

What is a good plan to deceive the Enemy with respect to the range of your Guns ?

A good plan to deceive the Enemy with respect to the range of the Artillery is, to load your Guns with only half the charge at the commencement of the Siege and this will be quite sufficient to protect the retreat of the advanced posts.

At what period of the Siege should the

Sorties should be made when the Enemy is commencing to make perma-

principal Sorties be made?

nent dispositions for their establishment and it is at this period that the Artillery of the place should make brisk cannonades on such posts as are within their reach.

On what points should the fire of the Artillery be principally directed?

The fire of the Artillery should be directed during the day to such parts of the parallel as are unfinished, and on the points of the Capitals where the zig-zags depart.

At what period of the Siege will the fire from Musketry be brought into play?

The fire from the Musketry will be first useful when the Enemy has commenced the second parallel, and although the range at this distance may be great, yet it may be directed with care and effect from the branches of the covert way.

Which is the best time for making a Sortie?

The best time for making a Sortie is at day break because the workmen of the besiegers are at this time fatigued.

In what part of the work are detachments for the Sortie assembled?

The detachments for the Sortie are assembled: the Infantry in the covert-way of the front attacked, the Artillery with Field pieces, and the Cavalry in the covertway of the collateral fronts right and left where they must wait without the least noise for the signal.

Where should the fire of the Garrison be directed against the besiegers when the Sortie has sallied out?

The fire from the Garrison ought to be directed on the wings of the Sortie.

What must the detachments composing the Sortie be accompanied with?

The detachments composing the Sortie must be accompanied by a number of workmen with their tools directed by Engineers in order to destroy the Enemy's works whilst another

party conducted by Artillery Officers spike the Guns and destroy the Carriages.

How ought the Detachments which compose the sortie to be posted whilst the above operations are carrying on?

The Infantry after overthrowing all they can of the Enemy's Troops will take post by divisions in front whilst the Cavalry and Artillery protect the wings.

How ought the retreat of the Sortie within the Garrison to be covered?

The retreat of the Sortie must be covered by some light pieces of Artillery placed on the salient angles in barbette and by Infantry posted in the covertway.

WHEN a breach has been made by the Enemy what is the best method for stopping it up?

When a breach has been made it must be stopped up with Chevaux-de-frise, Carriages, large boughs of Trees, &c. &c. hand Grenades, tarred faggots, &c. should also be in readiness to be made use of when required.

WHAT other precautions ought to be taken when a breach has been made?

After the passage of the breach has been secured in the best possible manner, two field pieces loaded with case shot should be kept in readiness on the ramps to run up so as to command the breach.

WHAT other expedients must be adopted when the enemy is about to assault the breach?

The houses ought to be blockaded, ditches cut in the streets and traverses erected. All useless pieces of Artillery should be likewise withdrawn from the ramparts and the Infantry destined to defend the breach must be stationed along the faces, flanks, and curtains attacked.

SIEGE ARTILLERY.

What quantity of Artillery is required for the Siege of a fortified place?

The quantity of Artillery requisite for the Siege of a fortified place must depend upon the force, situation, and condition of the place to be sieged and whether it is susceptible of more than one attack.

When a place is susceptible of more than one attack what is the consequence?

When a place is susceptible of more than one attack the consequence of course is, that more Artillery will be required, than for a place admitting only of one attack, but for this last there must be fewer pieces of Ordnance but more ammunition for each piece.

What number of Batteries will it be necessary to open before a fortified place?

There must be a Battery to enfilade every face of the work to be besieged, that, can in any way annoy the besiegers in their approaches.

Of what extent must these Batteries be?

These Batteries, at least that part of them to be allotted for Guns, need not be much longer than the breadth of the rampart to be enfiladed, and they will not therefore hold more than 5 or 6 heavy Guns; which with two more to enfilade the opposite branch of the Covertway, will give the number of Guns for each Ricochet Battery.

Will the same Guns serve for the breaching Batteries which first served for the Ricochet Batteries?

Yes; the same Guns will serve for both, as the breaching Batteries from their situation effectually mask the fire of the first or Ricochet Batteries, therefore the same Artillery generally serves for both.

What number of Mortars and Howitzers will be required

It will be necessary to have $\frac{1}{3}$d as many Mortars as Guns. These will consist of Mortars from 8 to 13 inch;

for the siege of a fortified place? — also $\frac{1}{4}$th small Mortars and $\frac{1}{8}$th of heavy Howitzers.

WHAT quantity of Ammunition will be required for each piece of Ordnance? — About 1000 rounds per Gun and about 800 for Mortars, Howitzers and Stone Mortars.

WHAT charge of Powder is used for Ricochet firing. — The charge is 2lb. for a 24 pounder, or one fourth the common Service charge. This varies according to the height of the work and the distance, it should not exceed $\frac{1}{4}$ the weight of the shot.

WHAT other kinds of Shot will be required for a Siege? — A certain quantity of case and grape Shot in the proportion of one round per day for each Gun, and these to be fired with a charge of $\frac{1}{4}$ the weigh of the shot.

Is there any other nature of Shot required? — It will also be necessary to have a certain number of carcases in the proportion of one for each Mortar per day.

WHAT other requisites are necessary at a Siege? — In case of lines being necessary a great quantity of intrenching Tools will be required and likewise a numerous field train of Artillery.

IN what manner is the Artillery generally arranged at a Siege? — The first arrangement of the Artillery at a Siege is at the different Batteries raised near the first parallel and these Batteries must enfilade the faces of the works attacked.

MAY the Artillery be continued in these Batteries nearly the whole of the Siege? — Yes, if these Batteries are favorably situated the Artillery may be continued in them till the besiegers arrive at the crest of the glacis.

WHICH are the best positions for Artillery to destroy the defences of the face of a work? — The most advantageous position for the first Batteries is perpendicular to the prolongation of the face of the work to be enfiladed.

WHICH is the next best position for the — The next best position for the Artillery to destroy the face of a work is

Artillery to destroy the face of a work? — on that side of the prolongation which takes that side in reverse and under as small an angle as possible and from both these positions the Guns must be fired in Ricochet.

Supposing the ground will not admit of batteries being constructed in any of the two above methods, how can the faces of a work in that case be destroyed?

If the ground will not admit of Batteries being constructed as above mentioned in this case the Ricochet Batteries to destroy the face of a work must be without the prolongation so as to fire obliquely on the outside of the face.

Which is the last position from which the defences of a place may be destroyed?

The last position from which the defences of a face may be destroyed is directly parallel to the face and from these two last positions the Guns must fire with the full charge.

Where are the breaching Batteries constructed at a Siege?

The breaching Batteries are constructed on the crest of the glacis within 15 or 18 feet of the covertway, and if the foot of the revetment cannot be seen from this situation, they must be placed within 15 feet of the counterscarpe of the ditch.

What precautions ought to be taken in constructing a Battery on the crest of the glacis?

In constructing a Battery on the glacis attention must be paid that none of the embrazures open upon the traverses of the covertway.

Of what number of Guns ought the breaching Batteries to consist?

The breaching Batteries should consist of at least four Guns and if the breadth of the traverses will not admit of this number, the Guns must be closed from 12 to 15 feet of each other.

In what manner is a breach commonly made by Artillery?

The Batteries to make a breach should commence by marking out as nearly as possible the extent of the breach

intended to be made; first by a horizontal line within a fathom of the bottom of the revetement in a dry ditch and close to the water's edge in a wet one.

WHAT is next to be observed in making a breach?

After the Guns have marked out a line within 6 feet of the bottom of the ditch, then lines perpendicular to this line must be made at a short distance from each other as high as the cordon; then by continuing to deepen all these cuts, the wall will give way in a body.

IN what manner should the Guns of a breaching Battery be fired in order to produce the greatest effect?

In order to produce the greatest effect the Guns of a Breaching Battery should be fired as nearly as possible in Salvoes or Vollies.

OF what length should a breach be made?

A breach should be made about one-third the length of the face from the centre towards the flanked angle.

AFTER the wall has given way should the firing be continued?

Yes, the firing should be continued in order to make the slope of the breach practicable.

How long will it require to effect a breach with four 24 Pounders?

With four 24 Pounders a breach may be made in four or five days and in three days more it may be made practicable.

WHERE are the Mortar Batteries erected at a Siege?

The Mortar Batteries are erected first near the Gun Batteries, or upon the prolongations of the Capitals of the work; in which situation they are certainly least exposed.

WHERE are the Howitzer Batteries constructed at a Siege?

The Howitzer Batteries are constructed on the extremities of the half parallels in order to enfilade the branches of the covertway.

ARE Howitzer Batteries constructed in

Yes, when the third parallel has been formed Batteries of Howitzers

any other position at a Siege?

and Stone Mortars may be constructed to enfilade the flanks of the bastions and annoy the besieged in the covertway.

What ought to be the principal object in the construction of all the different kinds of Batteries at a Siege?

The principal object in the construction of Batteries at a Siege ought to be to arrange them in such a manner that they may mask the fire of each other as little as possible and particularly of the first Ricochet Batteries.

How ought the Soldiers in the Trenches to be secured against the fire of their own Batteries?

To prevent the Workmen from being alarmed by the shot from their own Batteries passing over their heads, a parapet should be thrown up in rear of the Trenches in such parts where the fire from their own Batteries crosses them.

Of what dimensions are permanent Magazines generally constructed?

According to Vauban, permanent Magazines are commonly made 60 feet long, and 25 feet wide in the clear.

Of what thickness are the walls of these Magazines usually made?

The side walls of permanent Magazines are generally 8 or 9 feet thick, and if there is not to be an upper story 8 or 9 feet is a sufficient height.

How is the Arch formed for the roof of these Magazines?

The Arch for the roof of permanent Magazines is formed of layers of bricks arched one above the other and it ought to be 3 feet thick at the top.

How does the exterior surface of the above Arch terminate at the top?

The exterior surface terminates at an angle like a roof, and the whole must be 8 feet thick over the key stone of the Arch.

How are the long sides of these Magazines supported?

The long sides of permanent Magazines are supported by counterforts 6 feet thick and 4 feet long and they are placed 12 feet asunder.

Where are the Ventilators of these Magazines placed ?

The Ventilators are placed one in the centre of each open space between the counterforts or buttresses and they are made with a die across them of half a foot. These Ventilators are closed with plates of Iron.

How are the Windows of permanent Magazines usually placed ?

The Windows are placed in each end high up and they are opened and shut by means of a ladder.

How are the Windows secured ?

The Windows of these Magazines are secured each by two shutters made of plank 2 or 3 inches thick and the outer one is covered with sheet Iron, and both fastened with strong bolts.

How is the entrance to a permanent Magazine secured ?

The entrance is secured by two doors, one of which opens inwards and the other outwards, and the outward one is covered with sheet Iron.

What quarter should the Door of a Magazine face ?

The Door of a Magazine should if possible always face the South.

What precautions ought to be taken respecting the floor of a Magazine.

When constructing a Magazine care should be taken to raise the floor about 2 feet above the ground, to keep it free from damp.

How are Magazines secured externally ?

Magazines are secured externally by having a wall 10 feet high and 1½ feet thick built all round them at 12 feet distance.

What quantity of Powder will a permanent Magazine of the above dimensions contain.

A Magazine 60 feet long and 25 feet wide will contain about 1053 Barrels of Powder.

In what manner should Barrels of Powder be piled up in a Magazine.

The Barrels should be put up in piles of three each, for a greater number piled above each other destroys the Barrels, damages the Powder, and occasions accidents.

GUNPOWDER.

WHAT are the ingredients of which Gunpowder is composed, and the proportions of each?

Nitre, Charcoal, and Sulphur; the proportions differ with different Nations as shewn by the following Table.

	England.	France.*	Portugal.	Spain.	Sweden.	Poland.	Italy.	Russia.	Austria.	Madras.	China.	Berne.	Holland.
SALTPETRE.....	75	75	78	76	75	80	76½	70	76	75	75½	76	70
SULPHUR	10	9½	11	13	9	8	12½	11½	13	10	10	10	14
CHARCOAL.....	15	15½	14	11	16	12	12½	18½	11	15	14½	14	14
POUNDS...	100	100	103	102	100	100	101½	100	100	100	100	100	98

* According to the fabrication of Monsieur Champy, by order of the Committee of Public Safety.

		Saltpetre.	Charcoal.	Sulphur.
	A.	76	15	9
	B.	77	17	7
	C.	80	15	5
Ancient and resumed 18th August 1808		75	12½	12½
For Mines		65	15	20

WHAT is the expansive force of Gunpowder?

A Grain of Gunpowder if it is exactly spherical, when fired spreads its flame all round it to a distance of 8 times its diameter; consequently the

diameter of the inflamed Globe is equal to 16 times that of the grain; from which it is calculated that powder when reduced by inflammation into gas, occupies a space 4000 times greater than when in grain, or as 1 is to the cube of 16·4156.

On what does the expansive force of Gunpowder depend?

The explosive power of the composition depends fundamentally upon the quantity of elastic gas permanently generated, the rapidity of the inflammation and the degree of heat to which it is raised. The quantity of gas depends almost entirely upon the quantity and purity of the Charcoal, by the combustion of which it is produced; the Nitre being the cause of that combustion and furnishing one part of the generated gas from its own decomposed acid, as it does the other by converting the Charcoal into carbonic acid. The Sulphur promotes the rapidity of inflammation, and by its heat expands the gas at the moment of explosion.

Of what is the elastic fluid generated by the explosion of Gunpowder, composed?

The elastic fluid obtained by the explosion of Gunpowder, is composed of

Carbonic acid gas...49 pts.
Azote...............34 ,,
Hydro carbonate....10 ,,
Nitrous acid gas..... 5 ,,
Sulphurous acid gas.. 2 ,,

Has the size of the Grain any effect on the strength of the Powder?

In large quantities from pieces of Ordnance, the difference is not very material, but from small arms, the finer the Grains the more force the powder will have, and the less foul will the barrels become from firing.

Has the uniformity of Grain in size and shape any effect?

Yes, experience shews that the nearer the grains are alike in shape and size, the more regular will be the ranges from it.

What advantage has glazing or case-hardening Powder?

By glazing or case-hardening powder, the surface is not so susceptible of imbibing moisture from the air, and from the same cause, no angles being exposed (the operation of glazing by the friction of the grains against each other making them nearly spherical,) the powder in travelling is not reduced to dust in so great a degree as when not glazed.

Are there any disadvantages in glazing powder?

There being no projecting angles in the grains, the fire will not ignite it so rapidly as when not glazed, this is an object in small quantities from Fire-arms, but from pieces of Ordnance with large charges, it is not of so much consequence.

Is mealed Powder as strong as when made into grains?

No, formerly guns were loaded with mealed Powder, independent of the inconvenience, trouble and danger of it in this state, experience shews that it is not half so strong as when grained.

What causes Powder to get into lumps?

This is to be imputed to two causes—either the Sulphur dissolving from heat, or the melting of the Saltpetre from imbibing moisture,—in either case, the grains become glued or clogged together more or less.

Is the Powder destroyed when in lumps, or can it in any way be recovered?

When the lumps can with ease be reduced by the gentle pressure of the hand, and the shape of the grains are not materially altered, the Powder is not destroyed, but can be recovered by drying, that is, spread it

on Trays, or on Platforms and expose it to the heat of the Sun or stoves for a certain time, care being taken by raking, that all has the benefit of the heat alike—this mode will recover Powder so injured.

WHAT do you call Cylinder Powder?

When the Charcoal is prepared in Iron Cylinders

WHAT do your call Pit Powder ?

When the Charcoal is made in the usual manner by burning the wood in the open air in Pits.

HAS drying been found to have the effect of restoring or strengthening Powder ?

Yes, repeated experiments have shown that Powder taken out of a Magazine and proved without drying is considerably weaker than the remainder of the same Barrel aired for a few hours, and then proved under similar circumstances. All Powder should be dried and proved before sent on Service.

WHAT should be most guarded against in the preservation of Powder ?

Next to fire, moisture, which the Saltpetre attracts from the air ; it tends to dissolve it and thereby weakens or destroys the Powder, every possible means should be adopted to preserve the Powder from damp or moisture.

How is Powder usually carried on Service ?

In India what is not made up in Cartridges, generally on Bullocks, a 50lb. Barrel slung on each side the Animal.

How is Powder preserved on Service ?

A spot of ground is selected for it, as dry as possible, which is cleared, and drained if necessary, Tarpaulings placed on it, and the barrels put in horizontal rows on their sides, like Piles of Shot, the whole covered with Tarpaulings.

How much does a

A whole barrel when full con-

Powder Barrel contain? tains 100lb. and a half barrel 50lb. but it is usual only to put in 90 and 45lb. because leaving the Powder room to be shifted preserves it better.

This is doubtless good in Magazines, and the Barrels should be occasionally turned, but in travelling the Barrels cannot be too full, the less room the grains have to move about in, the smaller will be the quantity of dust worn from them by friction against each other.

19. What are the different marks on Powder Barrels?

English Gunpowder is distinguished by the following marks.

No. $\frac{1}{2}$ / L G	Cylinder / Large Grain.	Marked in red.
No. 2 / S G	Cylinder / Small Grain.	Marked in red.
No. 3 / F G	Cylinder / Fine Grain.	Marked in red.
S A	The Dust from No. 3 and F G Cylinder.	
R A	For rifle Arms.	
$\frac{4}{7}$ / $\frac{3}{7}$	Cylinder. / Restored.	mixed—marked white L G.

L G or F G in blue is powder made of Pit Coal.

R S { No. $\frac{1}{2}$ L G / No. 3 F G } marked in yellow is restored.

The red L G or S G denotes powder entirely made of the Cylinder Charcoal and is that which is now always used on Service.

The white L. G. being a mixed powder, is not so uniform as the other, and is therefore generally used in filling Shells or for any such other pur-

poses as do not require accuracy. All Powder for Service is mixed in proportions according to its strength so as to bring it as much as possible to a mean and uniform force

Madras Gunpowder is distinguished as follows.

L. G. large grain.

S. G small grain or musket.

F. G. fine grain or rifle.

The Barrels with red paint marks contain large grain powder, the initials of the Maker is also on each Barrel.

Blue paint, small grain or musket.
White paint, fine grain or Rifle.
Pt. always signifies Pit Charcoal.

How is Gunpowder generally proved? There are various modes, a Mortar is the most convenient for Powder intended for pieces of Ordnance, because the extent of the range can be better ascertained than from a Gun or Howitzer.

MADRAS. "At Madras the usual mode of proving Powder is from a brass 10 inch Mortar, Shell weighing 96lb. diameter 9 in. 8 ten. Charge 2lbs. Elevation 45d. The Shell should range 1,000 yards or the Powder is not considered proof."

ENGLAND. In England an 8 Inch Gomer Iron Mortar is used, with an Iron Ball exactly the same size as the Shell weighing about 65lbs. Elevation 45d. with 2oz. this Ball should be projected 180 feet ; and with 4oz 380 feet (of the best Powder), with Powder that has been redried, 2oz. will not give a longer range than 117 feet.

BOMBAY.

Instrument of Proof—" An 8 Inch Iron Gomer Mortar on an Iron Bed weight 8cwt. 2qrs. 2lbs, Charge 2oz. Elevation 45d.

An Iron Ball weighing 68lbs. diameter of which to be 7. 93 inches proof, range 189 feet.

Each quantity of Gunpowder to be proved separately, and the mean of three rounds, fired with the above Eprouvette be shewn in the proof report, together with the following particulars.

Quantity proved, Charcoal, whether of Milk bush, Dholl Stalk, &c. and whether burnt in Cylinder or Pit; Water distilled or otherwise, Saltpetre whether Bengal or Dholeera, and month of Manufacture.

A few drams to be ignited on a polished copper plate, residium or otherwise to be noted, color of the Powder whether glazed or otherwise, grain hard or soft, even as to size, round or angular, dusty or clean, and the date of proof.

BENGAL.

Differs not materially from the Bombay mode.

WHAT is considered the best mode of proving Powder?

" That which approximates nearest to actual Service, that is, from Pieces of Ordnance and Charges in common use, for Ordnance; and from Musketry for small Arms."

How is Powder proved from Muskets?

A Musket is charged with a Steel Ball and 4 Drachms of Powder, the Balls should perforate 15 or 16 half inch wet Elm boards, placed quarter of an inch asunder, and at the distance of 39 feet from the muzzle of the Musket;

wet mangoe planks are substituted at Madras; the usual penetration 11 or 12, the planks are slid into a frame, one behind the other, so that after each fire, those that have been struck can be easily taken out and replaced; the Musket is fixed in a rest horizontally.

What becomes of the ingredients when the Powder explodes?

They are dissolved into an elastic fluid, which at the moment of explosion while heated is said to occupy 4000 times the space the Powder itself did, and acts in every direction equally, but by being placed in a tube with one end stopped, as a piece of Ordnance the greater part of it is brought to act on whatever body as a shot, or shell, may be placed before it.

What precautions are necessary to preserve Powder from the effects of the atmosphere?

To keep it in as dry a place as possible, it imbibes moisture from the least exposure, the new barrels appear to be admirably calculated to preserve it, of copper tinned inside, and a wooden Barrel over it.

How is Powder kept in Magazines?

The Barrels in horizontal tiers one above another.

What precautions are taken in Magazines, to prevent Powder being injured by long keeping?

All Powder is ordered to be taken out and dried every six months at Madras, which is thus done. At large stations a Brick and Chunam Terrace about 24 feet square with a small wall round it, is made for the purpose. The bottom is covered with Powder Cloths; on these the Barrels are emptied, the Powder in no place above $2\frac{1}{2}$ inches in thickness, raked every half hour with wooden rakes, all lumps to be broken, should the Powder contain

much dust, or mealed Powder, it should be well sifted, for which purpose sieves are supplied, the weather should be free from moisture,—three hours in the heat of the day is sufficient, the Powder may then be rebarrelled and taken back to the Magazines.

WHEN the Powder is so much injured that it cannot be brought to Proof, is it totally lost?

No, by the following easy process the most expensive ingredient Saltpetre, may be extracted:—"Divide a Barrel of Gunpowder equally into 4 empty Barrels, fill them up with water, stir them well twice a day for three days, let them remain quiet for two days, pour off the liquor into shallow copper Pans, put them in the Sun to evaporate; in two days the Saltpetre will be obtained; by this means about a quarter of a Barrel of Saltpetre will be extracted from one of Gunpowder, the other ingredients might be extracted, but would scarcely be worth the trouble."

How much Powder will it take to fill a Rectangular Box?

To find how much Powder it will require to fill a given Box,—first, find the contents of the Box by multiplying the length, breadth, and depth together, then divide by 30, for the lbs. of Powder the Box will contain.

How is the quantity of Powder ascertained that will fill a Cylinder?

Multiply the square of the diameter, by the length, then divide by 38·2 for the lbs. of Powder.

WHAT quantity of Powder is required to blow up a cubic fathom of Soil?

The quantity of Powder required to blow up a cubic fathom, must of course depend entirely on the nature of the Soil; for light earth mixed with sand 11 lbs. of Powder is required to raise a cubic fathom; for common earth 12lbs.; strong sand 15lbs.; clay

or fat earth 16lbs. ; old and good masonry 18lbs. ; and rock 20lbs. of Powder.

How many pounds of Powder will a cubic foot contain?

This differs according to the density and size of the Grain ; at Madras several different Powders were placed in a cubic foot measure, and weighed as follows.

	Weight.		
	lbs.	oz.	drs.
Ishapore Ordnance	56	7	0
,, Musket	54	6	0
Allahabad Ordnance	55	5	0
,, Musket	53	3	0
Madras Ordnance	48	11	0
,, Musket	48	1	0
Bombay Ordnance	56	12	0
,, Musket	54	1	0

N. B.—Each of the above being the medium of three weighings.

ORDNANCE.

How are the principal pieces of Ordnance distinguished?	Into Guns, Mortars, Howitzers and Carronades.
WHAT do you call the calibre of a piece of Ordnance?	The diameter of the bore.
IN what state is a piece of Ordnance, said to be honey-combed?	When the surface of the bore is full of little cavities or holes.
How do you ascertain the size of a hole in the bore of a piece of Ordnance?	The position is ascertained by means of the Searcher, the wax on the point that enters it, will then shew the shape of the cavity.
WHAT is meant by scaling a piece of Ordnance?	It is cleaning the inside of a piece, by firing a small quantity of powder, in order to blow out any dirt or scales of rust which may adhere to the interior surface.
WHAT is the line of metal?	It is the visual line forming a tangent with the base ring and the swell of the muzzle.
WHAT is called the dispart of a piece of Ordnance?	It is half the difference between the diameter of the base ring and the diameter of the swell of the muzzle,—many Guns have the dispart fixed on the upper part of the muzzle as a sight.
WHAT is meant by tertiating a piece of Ordnance?	It is to examine the thickness of metal of the several parts, which is done with a pair of calibre compasses.
WHAT is meant by quadrating a piece of Ordnance?	It is to examine if the piece is truly placed on its carriage, and whether the wheels are of an equal height, which is done by means of a spirit level.

What is the range of a Piece of Ordnance?	It is the distance from any piece to the point where the projectile touches the ground, and remains at rest.
What is the point blank range of a piece of Ordnance?	When the piece is neither elevated or depressed but laid horizontally.
How is a piece of Ordnance rendered unfit for Service?	There are several ways of effecting this; if it is required merely for the moment to prevent the Enemy from using it, the usual method is to spike the piece, that is, drive a spike into the vent; but to render the piece of Ordnance permanently unserviceable, knock off one or both trunnions.
Of what metals are the pieces of Ordnance cast?	Iron and Brass.
What advantage have Brass Ordnance over Iron, or Iron over Brass?	Brass Ordnance are not so liable to burst, are lighter and consequently better calculated for Field Service. Iron Ordnance will stand a heavier firing and being much stronger, a larger charge.
Does the kind of metal of which the piece is made in any way affect the projectile?	No—with the same charge the projectile will have the same range and velocity, whether thrown from an Iron or Brass piece of Ordnance.
What are the different natures of Ordnance in common use?	A general change is about to take place at Madras with regard to the nature of Ordnance. At present it consists of;
Battering Guns.	Battering Guns, Iron 24, 18 and 12 Pounders. 24 Pounders on account of their great weight and difficulty in travelling are but seldom taken to the Field.
Field Pieces.	Field Pieces, 9 Pounders and light 6 Pounders, Brass.

HOWITZERS.	Howitzers Iron, the 10 and 8 inch, are not yet in general use A few have been sent out for experiment, and appear to be excellent pieces of Ordnance; the weight is against the 10 inch in this country.
	Howitzers Brass, $5\frac{1}{2}$ inch heavy, $5\frac{1}{2}$ inch medium, 24 and 12 Pounder; the latter is likely to be generally adopted.
MORTARS.	Mortars Iron, 13, 10, 8, $5\frac{1}{2}$ inch, Mortars Brass 13, 10, 8 $5\frac{1}{2}$ inch; the 13 inch is but seldom used except in Garrisons from its great weight.
CARRONADES.	Carronades, 68, 42, 32, 24, 18 and 12 Pounders Iron; these pieces are generally used for Sea Service.
How is a Gun denominated?	By the weight of its Shot in lbs; thus a Gun carrying a 24lb. shot is called a 24 Pounder.
How is a Carronade denominated?	In the same manner as a gun, by the weight of its shot.
How is a Mortar denominated?	By the diameter of its bore in inches; thus a Mortar whose bore is 10 inches is called a 10 inch mortar.
How is a Howitzer denominated?	Both by the diameter of the bore, and weight of shot that will fit it.
WHAT is the value of Brass Ordnance?	The value of all Brass Ordnance is about £ 84 17*s*. per ton for themetal, that is, for the weight of the Gun, and 12lb. per cwt. for waste; to this 64lb. must be added per ton for casting light pieces; 54lb. for medium, and 44lb. for heavy.
WHAT is the value of Iron Ordnance per ton?	Iron Ordnance is valued at £ 20 per ton.

How is Iron Ordnance generally proved?

Iron Ordnance undergoes several kinds of proof before being admitted into the King's Service. They are gauged as to their several dimensions internal and external, also in respect to the justness of the bore, chamber, vent, trunnions, &c.

What other methods are taken to prove Ordnance?

They are fired with a certain charge of powder and shot and afterwards examined to see that there are no holes in them, and water is then endeavoured to be forced through them by means of an engine, and lastly they are examined internally by means of light reflected from a mirror.

What charge of powder is used in proving Iron Guns?

$\frac{2}{3}$ the weight of the shot; also with one shot and two high junk wads, two rounds fired from each Gun.

In proving Iron Guns how much variation is allowed in the diameter of the bore?

No variation in the bore is allowed of more than ·033 of an inch from the 42 to the 18 Pounder, and ·025 from the 12 to the 4 Pounder.

In proving Guns how much variation in the position of the bore condemns them?

In the position of the bore any variation of more than half an inch out of the axis of the piece is sufficient to condemn heavy Guns, and $\frac{1}{3}$d of an inch for light Guns.

When Iron Guns have been proved by firing out of them what is next done?

They are examined internally, and if they have any holes or cavities in the bore $\frac{2}{10}$ of an inch in depth behind the first reinforce ring or $\frac{1}{4}$ of an inch before this ring they are then condemned.

In proving Brass Guns what is to be observed?

A greater nicety is required in proving Brass Guns than heavy Iron Guns, and any hole in the bore of ·15 of an inch deep is sufficient to condemn them.

What charge of powder is used in proving Brass Guns?

A charge of 3lbs. is given to light 9 Pounders and 2lbs. to light 6 Pounders, three rounds each with wads and shot.

How are Mortars and Howitzers proved?

The Mortars are proved on their beds with their chambers full of powder, and an Iron shell at about 75d. of elevation, and the Howitzers on their carriages at 12d, two rounds from each.

What is sufficient to condemn a Mortar after being proved as above?

Mortars having a hole ·1 of an inch in depth in the chamber, or ·15 in the chase are rejected.

What is sufficient to condemn a Howitzer after being proved as above?

A hole ·15 of an inch in depth in the chamber or ·2 in the chase is rejected.

How are Carronades proved?

Carronades are proved with two rounds having their chambers full of powder, and one shot and one wad.

Are there any other methods used in proving Guns?

Yes, Ordnance suspected of being bad are sometimes fired 30 rounds quickly, with the Service charge and two shot, and in doubtful cases recourse is had to chemical trials and analysis.

How are Guns proved chemically as to the goodness of the Iron?

A quantity of clean Iron filings is taken from any part of the gun which is free from rust, these are diluted in sulphuric acid and the quantity of gas disengaged is accurately ascertained. The plumbago also which remains is separated by filtration and carefully weighed.

How is the goodness or badness of the Iron proved by the above analysis?

The purer the Iron is, the greater will be the quantity of gas and the proportion of plumbago less. When the plumbago exceeds 4½ per cent. the Iron is bad, but in no instance whatever, has any gun been known to burst when the plumbago did not exceed 3 per cent.

WHAT else may be ascertained from the plumbago?

The colour of the plumbago must be attended to, for when it is brown or reddish it is an indication of hard metal, but when in quantities and mixed with coals the Iron is too soft for Cannon.

How is Ordnance marked which is condemned as unserviceable?

Ordnance condemned as being unserviceable is marked either × D, × S, or × W. The first denotes faulty in their dimensions, the second by the searcher, and the third by water.

How should Iron Ordnance be preserved?

For the care and preservation of Iron Ordnance, clear the exterior and interior of rust and dirt with the circular spring scraper, the bottom of the bore with the tool for that purpose, and the vent with the square rimer; after which the bore must be well brushed out. Lacquer the bore, to do which—fix a common painter's brush vertically on a long handle, when the first coat of lacquer is dry, apply a second. The bottom of the bore is lacquered, by a brush fixed horizontally on a long handle. The exterior of the piece to be well scraped with an old Sea service sword, or, steel tool. When the rust will not give way, it should be slightly hammered, and afterwards brushed off. Two coats of anti-corrosion are then laid on. The guns before coating, should be placed where they are to remain a short time; when skidded, they should be laid under metal, (i e.) with their muzzles rather lower than the breech, so as to prevent rain or dirt from lodging in the bores, which should be swept out occasionally. Guns should be coated and lacquered

about every fourth year. The above directions apply equally to Guns mounted on works and those skidded. The vent should be stopped up with putty, and a tompion fitted tight into the muzzle also with putty.

GUNS.

What is the usual shape of a Gun?

Its general form is the frustrum of a right cone, from which a cylinder described about its axis is taken away; the exterior part is ornamented with mouldings, and the thickness of metal in the whole length is different, in order to give to those several parts their proper solidity, where a greater resistance is required against the effects of the gunpowder."

Why is the thickness of metal made less towards the mouth of a Gun?

"The elastic force of inflamed gunpowder being in the inverse ratio of the capacity in which it is contained; its efforts against the sides of the piece will be much diminished when the shot has reached the mouth.

What are the principal parts of a Gun?

The first reinforce, the second reinforce, the breech, the cascable, the muzzle, the trunnions, the bore, and the vent.

What is the species of iron most proper for Guns and Mortars?

The pig-metal or cast iron, which possesses the greatest strength, and which is consequently most proper for casting guns and mortars, is that which is neither perfectly white, nor perfectly grey, but which is in an intermediate state between them.

How is the gun-metal composed, which is used for brass Guns and Mortars?

Copper and tin are melted together, in the proportion of 8 or 12lbs. of tin to 100lbs. of copper; this constitutes Gun-metal. The largest proportion of Tin is used for Mortars, where a greater degree of hardness is necessary.

Why is tin used in Gun-metal?

It renders the composition hard, and, by promoting the fusion of the

copper, communicates solidity to the mixture when cast into Ordnance.

WHAT is the use of copper in Gun-metal?

It gives with a due proportion of tin, strength and malleability to the composition; copper alone is of too soft and flexible a nature for Guns, and if too great a proportion of tin is used, it destroys the malleability.

THE length of a Gun being given in calibres, how is the same ascertained in feet and inches?

The product of the number of calibres multiplied by the diameter in inches of the bore or calibre is divided by 12, and the quotient will be the length in feet and inches.

How is the length of a Gun ascertained in calibres?

The length of the Gun being first taken in inches, the same is to be divided by the diameter of the bore, in inches, and the quotient will be the required number of calibres.

WHAT nature of Guns are called Battering Pieces?

Iron 24, 18, and 12 Pounders, in India; the 24 Pounder is too heavy to be dragged about, and is but seldom used, although a good piece of Ordnance.

WHAT nature of Guns are denominated Field Pieces?

Brass 12, 9, 6 and 3 Pounders at Madras; the 12 Pounder is obsolete.

WHAT is the proportion between the weight of the shot, and piece in Brass Guns?

About 100lb. of the metal to 1lb. of the shot.

WHAT is the proportion between the weight of the shot and piece in Iron Guns?

About 250lb. of metal to 1lb. of the shot's weight.

WHAT is the length of Brass Guns?

New 24, 18, 12, 9 and 6 Pounders—5 feet; the three former obsolete at Madras.

WHAT is the length of Iron Guns?	Generally from 18 to 20 calibres.
WHAT is the diameter of the vent of a Gun?	.2 of an inch for all Guns.
How is the weight of a piece of Ordnance ascertained?	By dividing it into as many sections, perpendicular to its axis, as may be found necessary to calculate its contents in inches, from which the contents of the bore being deducted, and the difference multiplied by 5.0833, will give the weight in ounces if Brass, and by 4.2968, when Iron.

Calibres of English and Foreign Guns expressed in English Inches.

English.		French.		Spanish.		Dutch.		Russian.		Portuguese.	
Pr.	Inches.	Pr.	Inches.	Pr.	Inches.	Pr.	Inches	Pr.	Inches.	Pr.	Inches.
42	7.018							36	6 86	48	7.49
32	6 41	36	6.9	36	6.81	32	6 4	30	6 47	36	6 8
24	5.823	24	6.03	24	6.03	24	5 92	24	6.	24	5 93
18	5.292	16	5 26	18	5.52	18	5 45	18	5.45	18	5 4
12	4.623	12	4.78	12	4.8	12	4 76	12	4.76	12	4.7
9	4 200	8	4.18	9	4.2	8	4 73	8	4 17	9	4 3
6	3 668	-				6	3.78	6	3 78	6	3.75
4	3.204	4	3 315								
3	3.013										
1	2.019										

Table of Brass Field Guns in Current Service 1827.

Nature.	Length.		Weight.			Nature.	Length.		Weight.		
	Feet.	Inches.	cwt.	qrs.	lb		Feet.	Inches.	cwt.	qrs	lbs.
Madras 9 Pounder.	5	8	8	3	15		6	0	6	0	0
English 9 Pounder	6	0	13	2	0	3 Pounder.	4	0	3	0	0
6 Pounder	7	0	12	0	0		3	0	2	1	0
	5	0	6	0	0	1 Pounder	5	0	2	2	0

Table of Iron Guns, in Current Land Service 1827.

Nature.		Length. Feet.	Length. Inches.	Weight. cwt.	Weight. qrs.	Weight. lbs.
24 Pounder		9	0	48	0	0
18 ,,		9	0	40	0	0
12 ,,	{	6	0	24	0	0
		6	0	21	0	0
9 ,,		5	6	17	0	0
6 ,,	{	4	10	11	0	0
		3	5	6	2	0

General Table of Brass and Iron Guns.

	Nature of Guns.	Cailbre. Inches.	Length of Gun, in Calibres.	Length of Gun, in Inches.	Length of Bore, in Calibres.	Length of Bore, in Inches.	Weight. Cwt.	Weight. Qr.	Weight. lbs.	Proportion between Shot and the Gun.
Brass.	12 Pdr. Med.	4.623	17.0	78.6	16.126	74.55	18	0	0	168
	12 Pdr. Light	4.623	13.0	60.079	12.245	56.61	12	0	0	112
	9 ,, ...	4.2	17.0	71.4	16.129	67 74	13	2	0	168
	6 ,, ...	3.668	22 9	84.0	21.906	80 35	12	0	0	224
		3.668	19.629	72.0	19.0	69 692	9	1	2	173
		3.668	16.358	60 0	15.669	57.47	6	0	0	112
	3 ,, ...	2.913	22.717	72.0	22.125	64.45	6	0	0	226
		2 913	16 478	48.0	15.791	46.0	3	0	0	112
		2 913	12.358	36.0	11.672	34 0	2	1	0	84
	1 ,, ...	2.019	29.718	60.0	28.718	59.981	2	2	11	291
Iron.	10 Inch	10.0	9.0	90.0	8.86	88.6	56	0	0	89.6
	68 Pdr.	8.05	10 0	80.5	10.0	80.5	50	0	0	82.35
	42 ,, ...	7.018	16.24	108 5	15.24	106.982	65	1	0	174
	32 ,, ...	6.41	17.8	108.5	16 723	107.2	55	2	24	195
		6.41	14 976	96.0	14.0	89.74	47	2	24	167
	24 ,, ...	5.823	19.577	108 5	18.458	107.41	50	0	16	234
		5.823	18.646	108 5	17.42	101.45	47	2	8	224
		5.823	16.486	96.0	15.37	89.5	43	2	0	203
		5.823	15.45	84.5	14.416	83.95	40	0	8	187
	18 ,, ...	5.292	20.4	108.0	19.22	101.75	42	0	12	262
		5.292	18.13	96.0	16.95	89.74	37	2	12	234
	12 ,, ...	4.623	23.36	108.0	22.113	102.23	35	3	24	317
		4.623	22.063	96.5	20.81	96.221	33	0	0	308
		4.623	19 467	84.5	18.22	84.25	29	2	8	276
	9 ,, ...	4.2	25.714	108.0	24.4	102.487	31	0	2	386
		4.2	24.285	96.5	23.0	96 48	28	2	3	355
		4.2	21.42	84.5	20.13	84.435	26	0	4	324
		4.2	20.0	84.0	18.68	78 48	24	3	27	311
	6 ,, ...	3.668	27.808	96.5	26.4	96.957	23	0	4	430
		3.668	26.17	96 0	24.79	90.956	22	0	2	411
		3.668	24.536	84.5	23.162	84 96	21	0	0	392
		3.668	22.92	84.0	21.52	78.952	20	0	4	374
		3.668	21.265	72.5	19 89	72.96	18	0	0	336
		3.668	19.629	72.0	12.25	66.97	17	0	4	316
	Madras Brass 9 Pdr.	4.2	16.2	68.	15.732	66.75	6	3	15	110

MORTARS.

In what does a Mortar differ from a Gun?

The trunnions are placed behind the vent at the breech, much shorter in proportion than a Gun, the powder is placed in a chamber, which is smaller than the bore.

How are the different parts of a Mortar distinguished?

The names of the several parts correspond with those of a Gun, a Mortar has seldom more than one reinforce.

What diameter is given, to the vent of Mortars?

Two-tenths of an inch.

What is the usual length of a Mortar?

No common Mortar exceeds 3 calibres in length of bore, or is less than 1.5—no exact length is fixed.

Why is a Mortar made with a chamber?

The smaller the space in which powder is confined, the more expansive force will it have when ignited.

What is the best shape for the chamber of a Mortar?

This appears to be a point not decided, four different kinds are used—cylindrical, conical with the base *outwards*, the same *reversed*, and spherical —The cylindrical chamber was the most common, of late General Gomer of the French Service has brought into general use the conical chambers with the base outwards of such a size that the sides of the bore form tangents to it, by which means the shell completely fills the space allotted to it and as the axis of the shell corresponds with that of the bore, the former will not be forced out of its direction by more of the fluid acting on one part than another.

Is the range of a projectile greater

No, it has been experimentally ascertained, the range of a projectile

from a Gorner chamber than from a common cylindrical chamber.

from a Gorner chambered Mortar, is less than from any other shape, because the powder has more room to expand itself before it reaches the projectile, than in any of the common shaped chambers.

WHY are the trunnions of Mortars placed at the breech?

Because Mortars are usually fired at very high elevations; if placed as in Guns, it would be very difficult to give them these elevations, and they would be apt to turn over after every discharge.

Formerly the trunnions of Mortars were placed about the middle of the reinforce, and altered to their present position under an idea, that thereby their beds would suffer less when fired.

WHY are Mortars usually fired at high elevations?

Shells are intended to fire Magazines, &c. and to break through the roofs of which, it is necessary to give them the greatest possible power, by allowing them the full effect of gravity, which to a certain extent increases the weight of the falling body in proportion to the space through which it descends.

WHY are Mortars not mounted on wheel carriages like Guns?

On account of the high angles at which they are fired, the recoil instead of forcing the piece back, in this case tends to force it downwards, which tendency increases as the angle of elevation, and no wheel carriages could support the shock.

WHY are Mortars shorter than Guns?

From the situation of their trunnions, if made as long as Guns they could not be properly balanced on their bed, and would be so top heavy as to be unmanageable?

WHAT is a Stone Mortar?	It differs from a common Mortar in being of lighter construction, the calibre is larger, generally 15 inches, its chamber containing from 2 to 3lbs. of powder only.
FOR what purpose is it intended?	To throw baskets of stones short distances, not exceeding 150 or 200 yards.
FOR what particular service are Stone Mortars adapted?	At sieges they are generally placed in the angles of the covert way, to annoy the enemy in their approaches.
How are Stone Mortars loaded?	The powder being placed in the chamber, a cylindrical piece of wood fitting the chamber is put on it, so as completely with the powder to fill it, a basket shaped to the bore filled with stones is placed on it.
WHAT sized stones are usually thrown from Stone Mortars?	The stones generally made use of are pebbles the size of a man's fist and as round as can be found.
WHY are Stone Mortars fired with such small charges?	Larger charges would reduce the stones to dust, consequently the Mortars themselves are only made of sufficient strength to stand these charges, and would be destroyed if the powder was much encreased.

Weight and Dimensions of Land and Sea Service Mortars.

	Nature of Mortars.	Calibre.	Length of Mortar.	Length of Bore.	Weight.			Chamber. Length.	Chamber. Diameter. Superior.	Chamber. Diameter. Interior.
		Inches	Inches	Inches	cwt	q	lb	Inches	Inches	Inches
Land Service.	13 Inch Iron...	13 0	36.563	26.0	36	20	0	13.0	13.0	7.5
	10 " "	10.0	28.125	20.0	16	2	0	10.0	10.0	5.0
	8 " "	8.0	22.5	16.0	8	2	14	8 0	8.0	4.0
	13 " Brass..	13.0	45.0	22.9	25	1	0	14.0	6.8	3.6
	10 " "	10.0	33.0	16.8	12	0	0	9.5	5.0	2.8
	8 " "	8.0	25.5	13 3	6	0	0	7.0	4.1	2.3
	5½ " "	5.62	15.104	11.948	1	1	15	4.1	2 8	2.0
	4⅖ " "	4.52	12.713	10.17	0	3	20	3.8	2.25	1.75
Sea Service.	13 Inch Iron..	13.0	52 81	39.0	100	1	14	13.0	9.75	7.312
	10 " "	10.0	45.62	35 0	52	0	0	10.0	7.5	5.64

HOWITZERS.

How is a Howitzer distinguished from a Gun or Mortar?	A Howitzer in external shape differs not from a Gun, except in being shorter, and is mounted on a wheel carriage in a similar manner, the bore corresponds with that of a mortar having a chamber to contain the charge of Powder.
What is the usual length of a Howitzer?	Varies as much as in Guns.
What particular advantage have Howitzers over other pieces of Ordnance?	Howitzers from being mounted on wheel carriages can be transported with Troops, and are in this point of view more convenient than Mortars, and, although their carriages are not sufficiently strong to admit of such high angles of elevation, they answer the purpose for which they are intended, ricocheting Troops, destroying field works, breaking down palisades, burning buildings, &c. the largeness of their bores enables them to throw a much larger projectile than any Gun that can be used as a Field piece, they are particularly useful in the instances above given.
Can a Howitzer be used as a Mortar, that is fired at very high elevations?	Yes, by taking off the wheels, and if necessary digging away the earth under the trail, so as to admit of the required elevation being given.
Is the Powder in cartridges as with Guns, or loose as with Mortars?	The Powder is in cartridges, and varies in quantity according to circumstances.
Has not a new description of Howitzer	Yes, General Miller of the Royal Artillery, has introduced Iron 10 and

lately been established?

8 inch Howitzers, also Brass 24 and 12 pounder Howitzers longer than those in common use and much lighter than the Guns of the same calibre.

For what purpose are the Iron 10 and 8 inch Howitzers intended?

For firing at Ships, a 10 or 8 inch shell fired in a horizontal direction would have much more chance of striking a Ship, than when fired at a high angle, and a shell of this size bursting in the side of a Ship, must have a tremendous effect. At sieges also large shells thrown into a breach would have great effect, acting as a mine, and bringing it down much quicker than round shot.

What advantages have the Brass 24 pounder and 12 pounder Howitzers?

They are much longer than the Howitzer in present use, range farther, and, shot with effect, can be thrown from them.

Table of Howitzers in present use.

Nature.	Weight.			Length.		Length in Calibres.	Chamber contains	
	cwt.	qrs.	lb.	ft.	in.		lb.	oz.
10 Inch Iron	39	2	2	5	0	6	7	0
8 ,, ,, ...	20	3	7	4	0	6	4	0
24 Pdr. Brass English	13	0	0	4	9	10	2	8
24 ,, ,, Bengal	8	3	5	4	0	8¾	2	8
12 ,, ,, English	6	0	0	3	9½	10	1	8
5½ Inches ,, Heavy	10	0	0	2	8½	6	3	0
5½ ,, ,, Med.	7	0	0	2	4½	5	2	0

How many 5½ inch Howitzers are there?

The heavy and light, at Madras lately a medium 5½ inch Howitzer has been introduced by Major Goreham of the Madras Artillery.

Is the heavy 5½ inch Howitzer a good piece of Ordnance?

Yes, but its weight is against it as a Field Piece.

Is a medium 5½

The medium 5½ inch Howitzer is

inch Howitzer a good piece of Ordnance ?

considered the best of that calibre, its weight is not too great for its being attached to Horse Artillery, and its length and charge, is sufficient to ensure a long and correct range.

Is a light $5\frac{1}{2}$ inch Howitzer agoodpiece of Ordnance ?

The light $5\frac{1}{2}$ inch is the most uncertain in its range and direction, of all other pieces of Ordnance, on account of its shortness, and is now become obsolete in every service.

As the same shell fits a $5\frac{1}{2}$ inch and 24 pdr. Howitzer why are both pieces in use ?

The heavy $5\frac{1}{2}$ inch carries a larger charge than the 24 pdr. Howitzer, but this is more than compensated by the length of the latter.

The 24 pdr. Howitzer is a new piece of Ordnance and no doubt when brought into general use, will supercede the $5\frac{1}{2}$ inch of every description.

Is the $4\frac{2}{5}$ inch Howitzer a good piece ?

At Madras it is obsolete, its length and smallness of the charge is much against it—Case Shot from this piece has little or no effect.

The 12 pdr. Howitzer carrying a shell the same size, will probably supercede its use in all services.

Is the 8 inch Brass Howitzer a good piece of Ordnance ?

At Madras it has become obsolete, from its weight, and difficulty of getting a carriage sufficiently strong to stand its fire.

The Iron 8 inch Howitzer has superceded its use also at Home.

What objections are there to short Howitzers ?

The difficulty of constructing a carriage sufficiently strong to stand the fire with large charges and great elevation.

General Miller's Howitzers will in all probability replace the $5\frac{1}{2}$ Inch and other Howitzers now in use, they are superior in range, effect and steadiness.

CARRONADES.

In what does a Carronade differ from a Gun or Howitzer?	It differs from both, in having no trunnions, fastened to its carriage by a loop underneath, has a chamber for its charge of powder and the elevating screw made to pass quite through the cascable, there is also a thin projection of iron beyond the muzzle—its length about the same as a Howitzer.
Of what metal are Carronades made?	Iron.
How are the names of its different parts distinguished?	In the same manner as those of a Howitzer.
For what particular service are Carronades intended?	Sea-Service, they are seldom used on Land; Carronades are generally placed on the upper deck of Ships, tops, boats, &c. their length and weight admits of their being moved without inconvenience.
What is the projection beyond the muzzle for?	To carry the explosion clear of the sides of the Ship.
Why have Carronades no trunnions?	Their carriages must be adapted to the port holes; with the loop, the piece can be elevated or depressed much more than with trunnions as is evident by inspection.

Weights and Dimensions of Carronades.

Calibre.	Inches.	Length of Carronade in Calibres.	Length of Carronade in Inches.	Length of Bore in Calibres.	Length of Bore in Inches.	Weight. Cwt.	Weight. Qr.	Weight. lbs.	Proportion between the Shot and Carronade.
68 Pdr.......	8.05	7.702	61.72	7.702	61.72	36	0	0	59
	8.05	5.962	48.0	5.962	48.0	29	0	0	
42 ,, ...	6 84	7.518	52.425	7.518	52.425	22	0	0	58
32 ,, ...	6.25	7.679	47.71	7.679	47.71	17	0	0	62
24 ,, ...	5.68	7.656	43.32	7.656	43.32	13	0	0	56
	5.68	6 336	36.0	6 336	36 0	11	2	0	
18 ,, ...	5.16	7.587	39 3	7.587	39·3	10	0	0	56
	5.16	5.447	28.0	5.447	28 0	8	1	0	
12 ,, ...	4.52	5 778	32.361	5.778	32.361	6	0	0	56

GUN CARRIAGES.

What proof do Gun Carriages undergo at Madras?

For Gun Carriages heavy and light 15 rounds per carriage full service charge with one shot.

5 rounds at P. B.
5 ,, ,, Medium Elevation.
5 ,, ,, Greatest Elevation the Carriage will admit of.

For Howitzer Carriages heavy and light 15 rounds with a dead shell.

CHARGE.

10	Inch Iron	7	0
8	do.	3	8
$5\frac{1}{2}$	H Brass	2	0
$5\frac{1}{2}$	Med.	1	8
24	Pr. Brass	2	0
12	Med.	1	8

5 rounds at P. B.
5 ,, ,, Medium Elevation
5 ,, ,, Greatest Elevation the Carriage will admit of.

Do Carriages of a new construction undergo a more severe proof?

Carriages of a new construction undergo a much more severe proof than the foregoing, sometimes 100 rounds are fired and frequently more, usually half at P.B. and the remainder elevated between the highest and Medium Elevation the carriage will admit of.

BATTERING TRAIN:

What kind of Carriages are battering Guns mounted on?

The common cheek Carriage with a Limber. A new description is about to be introduced, the cheeks

meeting at the trail by which means the carriage can be turned in less space, it has double trunnion boxes, called the *fighting* and *travelling* boxes, the piece is placed in the latter when travelling by which means the weight is thrown farther forward and more equally divided between the four wheels. The second trunnion boxes are 4 diameters of the bore behind the first. Formerly heavy Guns had two kinds of carriages in the Field, one as above described (without the travelling trunnion boxes) and a Transport Carriage.

Now, Transport Carriages are only used for the heaviest calibres, 24 pounders and 13 inch Mortars, the travelling trunnion boxes, rendering them unnecessary for lighter Guns.

WHAT is a Transport Carriage?

A Transport Carriage consists of an axletree mounted on two very high wheels, to keep the Gun which is slung under it, with the muzzle towards the cattle, clear of the ground or any obstacles in the road, two cheeks are attached to this axletree connecting it with a common limber.

How are Guns slung and unslung to Transport Carriages?

The Gun is laid on the ground and raised with handspikes to allow a small log of wood being placed under the muzzle and another under the breech to admit the lashing ropes passing freely under the piece. The Carriage is unlimbered and placed with a wheel on each side the Gun, the cheeks are raised so as to lower the hind part as near to the breech as

possible, to which it is firmly lashed with strong ropes, the cheeks are then hauled down nearly to touch the muzzle which is lashed to them, the Carriage limbered up, and the piece raised as close to the axletree and cheeks as it can be. To save the constant stress on the lashing ropes when halting, a log of wood should be placed under the breech and muzzle, for the Gun to rest on. To unsling the Gun the Carriage is unlimbered, the cheeks are lowered till the muzzle rests on the log of wood placed to receive it, when the lashings are undone and the cheeks raised until the breech in like manner rests on its log, when it is unlashed, the Carriage is then withdrawn from over the Gun.

How is a heavy Gun mounted on its travelling Carriage?

By means of a Gin which is erected over it, the sling is lashed to the Gun and the hook of the tackle lowered to admit of its being made fast to the loop in the Gun sling and then the Gun is raised by the windlass; when the Gun is sufficiently high the Carriage is run under it, and the piece gently lowered, till the trunnions are in their boxes, the lashings are then undone, and the Carriage run from under the Gin.

How is a heavy Gun dismounted from its travelling Carriage?

Also by means of the Gin which is erected over the Gun on its Carriage, the sling is lashed to the Gun, the cap squares opened and the tackle fastened to the sling, the windlass is worked and the Gun raised, first clear of its Carriage, which is drawn out of the way, and the Gun gently lowered to the ground.

Is there no other mode of mounting a heavy Gun but by a Gin?

Yes,—the best way without any machine is to dig a hole and place the muzzle in it, the breech upwards, so deep that when the head of the Carriage, is run up to it, and trail raised, the trunnions may come in their boxes, key them down and lower the trail.

It will be necessary to dig ruts also for the wheels; or the trunnion boxes will be higher than the trunnions.

On what general principle are Carriages for heavy Ordnance constructed?

The wheels and axletree for both Gun and limber are of the same size, so that if a Gun wheel is disabled it can be replaced from the limber.

The wheels and axletrees of 18 and 12 pounders are exactly of the same size at Madras.

WEIGHT of HEAVY FIELD CARRIAGES.

			English (cwt. qrs. lb.)	English total (cwt. qrs. lb.)	Madras	Madras total
24 Pdr.	Gun		47 2 0	79 1 0	48 1 0	94 1 0
	Carriage		24 1 18		30 0 0	
	Limber		7 1 10		16 0 0	
18 Pdr.	Gun		38 2 0	63 1 3	38 2 0	77 2 0
	Carriage		17 1 21		24 0 0	
	Limber		7 1 10		15 0 0	
12 Pdr.	Gun		32 2 0	56 0 10	34 2 0	69 2 0
	Carriage		16 1 0		22 0 0	
	Limber		7 1 10		13 0 0	
Carriages.	Platform			21 0 3		
	Devil. Large.	Limber	10 0 22	28 3 1	12 0 27	40 2 18
		Body	18 2 7		28 1 19	
	Devil. Small			7 2 8		
	Drag.	Large		14 0 0		
		Small		5 1 10		
	Pontoon			12 1 8		
Waggons.	Flanders			15 2 1		
	Small Arm Ammunition.	Limber	7 2 4	14 3 2		
		Body	7 0 26			
	Baggage			18 0 0		
Carts.	Trench			2 2 13		
	Sling			16 2 2		
	Baggage			8 3 14		
	Hand			2 1 23		

Why are Madras Carriages so much heavier than English ones?

On account of the bad roads in India, they are required to be made stronger, and besides all materials required for repairs must be carried in the Park, no workmen or materials can be procured in this country as in Europe, in the different villages or towns.

Will heavy Field Carriages answer for Garrison Guns?

Yes.

FIELD CARRIAGES.

Is there any general system regarding Field Carriages and Waggons at Madras?

Yes for 9, and 6 Pounders, 24 and 12 Pounder Howitzers block or beam trail Carriages are used. The beam consists of two pieces of wood dove tailed together, each cheek forming part of the half beam; formerly the beam was one solid block, and the cheeks bolted on, this was not found to answer, not only from the difficulty of getting wood of the proper size, but sometimes the inside was found to be decayed, which was not observable in any external examination of the carriage; this cannot well be the case with the half beams without being discovered, the cheeks were also found to split on firing, particularly when the three connecting bolts were in a line, corresponding with the grain of the wood. The Gun and Limber wheels of these Carriages, and of all Ammunition Waggons and Carts are exactly of the same dimensions and can indiscriminately be applied to each other, the naves of the wheels are brass, all ammunition boxes are of the same dimensions and answer for all the above description of Ordnance. The boxes themselves can easily be removed from the frame of the waggon, which admits of their being carried by hand, stowed away in magazines or on board Ship, where it might be impracticable to place or take the waggon; the limbers and boxes of these carriages and also of ammunition wag-

gons, correspond in every respect and can be used indiscriminately, the limber of the waggon has exactly the same quantity and kind of ammunition as the limber of its piece, so that when in action, if the latter is emptied the limber of the waggon fully loaded, replaces it and the Gun limber falls back to the waggon and is refilled from its ammunition boxes.

Is the beam trail Carriage the only one in use for field Ordnance?

From the difficulty of procuring wood of sufficient dimensions for the beam, a new construction has lately been introduced at Madras, which answers fully as well as the beam-trail, and is much lighter, and will doubtless be in general use. The carriage is composed of two cheeks, which meet at the trail and can by this means turn in as small a space as the beam trail carriage, and wood can always be procured of the proper size. We are indebted to Lieutenant Colonel Cullen for the introduction of this carriage.

What advantage have block or beam over cheek Trails?

The block or beam being narrower, turns in a less space, and is more handy in limbering up.

What advantages have brass Naves?

They last much longer than wooden Naves, the latter are very apt to split, particularly in removing a broken spoke and fitting in a new one, which takes much time: with the brass Nave, to replace a broken spoke the tire of the wheel must be taken off and the fellie to which the spoke is fixed; this is common to both Naves, unscrewing the nutt from one of the bolts on either side of the broken spoke, and drawing out the bolt will

admit of the broken spoke being removed, and replaced instantly. Brass Naves are only used at Madras, Iron Naves are about to be introduced for all heavy and park carriages. By having boxes of different sizes to fit into the naves, two sizes will answer for all light carriages, and one for all heavy carriages, for this we are also indebted to Lieutenant Colonel Cullen.

WHAT objections have been made to cast iron Axletrees?

Cast iron Axletrees were in use for a considerable time, with the Horse Artillery, and had a fair trial, but so frequently snapped asunder particularly in rapid movements, that it was deemed necessary to replace them by wooden ones; that is, the arms are of iron, as formerly, connected by a thin iron bar, which is bedded in wood; this is more elastic and gives instead of snapping.

WEIGHT OF FIELD LIGHT CARRIAGES.

		English			Subtotal	Total	Madras	Subtotal	Total
***Medium* 12 Pounder Brass.**									
Gun, &c.	Gun	18	0	0	30 3 9	42 0 23			
	Carriage	12	3	9					
	Limber	8	3	6	11 1 14				
	Ammunition	2	2	8					
Waggon, &c.	Limber	8	1	4	12 3 12	28 2 16			
	Ammunition	4	2	8					
	Body	8	3	20	15 3 4				
	Ammunition	6	3	12					
***Light* 12 Pounder Brass.**									
Gun, &c.	Gun	12	0	0	23 2 9	36 0 18			
	Carriage	11	2	9					
	Limber	8	1	5	12 2 9				
	Ammunition	4	1	4					
Waggon, &c.	Limber	8	1	5	12 2 9	27 3 25			
	Ammunition	4	1	4					
	Body	8	3	20	15 1 16				
	Ammunition	6	1	24					
9 *Pounder Brass.*									
Gun, &c.	Gun	13	2	0	25 1 6	37 0 5	8 3 15	19 3 1	34 2 20
	Carrriage	11	3	6			10 3 14		
	Limber	8	0	17	11 2 27		11 0 0	14 3 19	
	Ammunition	3	2	10			3 3 19		

		English			Madras		
Waggon &c.	Limber	8 0 17	11 2 27	27 2 13	11 0 0	14 3 19	30 1 26
	Ammunition	3 2 10			3 3 19		
	Body	8 3 24	15 2 14		10 2 0	15 2 7	
	Ammunition	6 3 18			5 0 7		

Heavy 6 Pounder Brass.

Gun, &c.	Gun	12 0 0	23 0 26	35 0 2
	Carriage	11 0 26		
	Limber	8 0 24	11 3 4	
	Ammunition	3 0 8		
Waggon, &c.	Limber	8 0 24	11 3 4	27 3 17
	Ammunition	3 2 8		
	Body	8 3 21	16 0 13	
	Ammunition	7 0 20		

Light 6 Pounders Brass.

Gun, &c.	Gun	6 0 0	15 0 26	26 0 15	6 0 0	17 2 0	32 0 24
	Carriage	8 3 6			11 2 0		
	Ammunition	0 1 20					
	Limber	8 0 5	10 3 17		10 3 0	14 2 24	
	Ammunition	2 3 12			3 3 24		
Waggon, &c.	Limber	8 0 5	11 1 25	27 2 6	10 3 0	14 2 24	30 3 10
	Ammunition	3 1 20			3 3 24		
	Body	8 3 21	16 0 9		10 2 0	16 0 14	
	Ammunition	7 0 16			5 2 14		

Heavy 3 Pounder Brass.

Gun, &c.	Gun	6	0	0	14	3	14	25	2	17		
	Carriage	8	1	24								
	Ammunition	0	1	8								
	Limber	8	0	6	10	3	13					
	Ammunition	2	3	7								
Waggon, &c.	Limber	8	0	6	10	3	13	26	2	3		
	Ammunition	2	3	7								
	Body	8	3	18	15	2	18					
	Ammunition	6	3	0								

Ammunition Cart.

Cart	10	0	15	15	3	1
Ammunition	5	2	14			

SPARE GUN AND WHEEL CARRIAGES.

					English.			Madras.		
12 Pdr. Medium.	Limber	8	2	11						
	Wheelers Tools									
	Carriage	13	1	21	22	2	10			
	Spare Articles	9	0	17						
12 Pdr. Light	Limber	7	3	11						
	Wheelers Tools									
	Carriage	12	0	16	21	1	12			
	Spare Articles	9	0	24						
9 Pdr.	Limber	7	3	11	....			11	0	0
	Wheelers Tools									
	Carriage	12	2	14	21	3	8	10	3	14
	Spare Articles	9	0	22						

					English.	Madras.
6 Pdr. Heavy	Limber	7	3	11		
	Wheelers Tools					
	Carriage	11	2	4	22 2 26	
	Spare Articles	9	0	22		
6 Pdr. Light	Limber	7	3	11	....	10 3
	Wheelers Tools					
	Carriage	9	2	12	17 1 15	11 2 0
	Spare Articles	7	3	3		
3 Pdr. Heavy	Limber	7	3	11		
	Wheelers Tools					
	Carriage	9	0	15	16 3 18	
	Spare Articles	7	3	3		

What is a pole bar and its use?

A small iron bar that crosses the end of the pole of a Gun Carriage underneath. The Horse Artillery only have it, its use is to allow the Horses to stand square to their draft, it passes through a ring at the under part of the collar of each wheel or pole horse, there are checks to prevent the horses separating too far, the linking chain also effects this.

What is a pole strap and its use?

A pole strap, is a leather strap, fixed to the end of a Carriage pole, one on each side, buckled to the collar ring of the pole horses, to keep their heads to the pole, but the pole bar, has superceded the use of the pole strap, this latter by keeping the horses heads towards the pole causes their rumps to project out, and destroys the parallelism of draft. A horse whose head is free, will work much better, and with more comfort to himself than when he has not a free play with his head.

HOWITZER CARRIAGES.

WHAT proof do Howitzer Carriages undergo?	See Gun Carriages, page 55.
WHAT proof do new con-constructed Howitzer Carriages undergo?	The same as new constructed Gun Carriages.
Do Howitzer Carriages differ from Gun Carriages?	The Carriagesfor Brass Howitzers are all on the same construction as Field Guns,

WEIGHT OF HOWITZER CARRIAGES.

		English.			Madras.		
10 Inch Iron Howitzer	Howitzer	39 2 20	76 2 6				
	Carriage	29 2 4					
	Limber	7 1 10					
8 Inch Iron Howitzer	Howitzer	20 2 0	49 3 10				
	Carriage	22 0 0					
	Limber	7 1 10					
Waggon, &c.	Limber	8 1 14	13 0 22	28 3 19			
	Ammunition	4 3 8					
	Body	9 1 5	15 2 25				
	Ammunition	6 1 20					
24 Pdr. Howitzer Brass, &c.	Howitzer	12 0 0	24 2 0	37 0 19	8 3 5	20 0 5	34 2 10
	Carriage	12 2 0			11 1 0		
	Limber	8 1 3	12 2 19		11 0 0	14 2 5	
	Ammunition	4 1 16			3 2 5		
Waggon, &c.	Limber	8 1 3	12 2 19	28 0 23	11 0 0	14 2 5	30 3 5
	Ammunition	4 1 16			3 2 5		
	Body	8 3 22	15 2 4		10 2 0	16 1 0	
	Ammunition	6 2 10			5 3 0		

Heavy $5\frac{1}{2}$ Inch Howitzer Brass.

		English.			Madras.		
Howitzer, &c.	Howitzer	10 0 0	22 3 15	35 2 6	10 0 0	25 1 20	41 3 25
	Carriage	12 3 15			15 1 20		
	Limber	8 1 3	12 2 19		13 0 0	16 2 5	
	Ammunition	4 1 16			3 2 5		

		English									Madras								
Waggon, &c.	Limber	8	1	3	12	2	19	28	0	23	11	0	0	14	2	5	30	3	5
	Ammunition	4	1	16							3	2	5						
	Body	8	3	22	15	2	4				10	2	0	16	1	0			
	Ammunition	6	2	10							5	3	0						

Medium $5\frac{1}{2}$ *Inch Howitzer Brass.*

		English									Madras								
Howitzer, &c.	Howitzer	....	....	....							7	0	0	18	2	25	33	1	2
	Carriage	....	....	....							11	2	25						
	Limber	....	....	....							11	0	0	14	2	5			
	Ammunition	....	....	....							3	2	5						
Waggon, &c.	Limber	....	....	....							11	0	0	14	2	5	30	3	5
	Ammunition	....	....	....							3	2	5						
	Body	....	....	....							10	2	0	16	1	0			
	Ammunition	....	....	....							5	3	0						

12 *Pounder Howitzer Brass.*

		English									Madras								
Howitzer, &c.	Howitzer	6	2	13	16	1	17	27	3	24	6	2	10	17	2	3	31	3	18
	Carriage	9	3	4							10	3	21						
	Limber	8	0	21	11	2	7				10	3	10	14	1	15			
	Ammunition	3	1	24							3	2	5						
Waggon, &c.	Limber	8	1	3	11	2	17	25	3	11	10	3	10	14	1	15	29	3	26
	Ammunition	3	1	14							3	2	5						
	Body	8	3	22	14	0	22				10	2	0	15	2	11			
	Ammunition	5	1	0							5	0	11						

SPARE HOWITZER AND WHEEL CARRIAGES.

8 Inch Howitzer Iron.	Limber	7	1	10	33	1	16			
	Wheelers Tools									
	Carriage	22	0	0						
	Spare Articles	11	1	16						
24 Pdr. or 5½ Inch Howitzer	Limber	8	1	3	21	1	26	11	0	0
	Wheelers Tools									
	Carriage	12	2	2				12	0	0
	Spare Articles	8	3	24						
12 Pdr. Howitzer	Limber	8	0	21	17	2	7	10	3	10
	Wheelers Tools									
	Carriage	9	3	4				10	3	21
	Spare Articles	7	3	3						

MORTAR BEDS.

WHAT proof do Mortar beds undergo?

Five rounds each bed; chamber ⅔ full at 60° elevation with a dead shell.

OF what construction are Mortar beds?

Simply two sides or cheeks connected by three cross pieces of wood called transoms, the Mortar is united to its bed in the same manner a Gun is to its carriage, by means of the trunnions, let into the cheeks and keyed down.

How are Mortar beds carried?

On Platform Carts,

WEIGHT and DIMENSIONS of MORTAR BEDS at Madras.

NATURE OF ORDNANCE.	Weight.			Dimensions.					
				Length.		Breadth.		Height.	
	Cwt.	Qrs.	lbs.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.
Iron 13 inch. Iron bed	52	3	7	5	0	3	4	1	4
Brass 13 ,, Wood ,,	19	1	0	7	0	3	0	1	6
Iron 10 ,, Iron ,,	21	1	17	4	4	2	$6\frac{1}{2}$	1	2
,, 10 ,, Wood ,,	14	1	19	7	0	2	7	1	$8\frac{1}{2}$
Brass 10 ,, Wood ,,	14	0	10	7	0	2	7	1	6
Iron 8 ,, Iron ,,	12	1	4	3	6	2	0	1	0
,, 8 ,, Wood ,,	8	0	7	5	7	2	0	1	5
Brass 8 ,, Wood ,,	7	3	1	5	6	2	1	1	3
Brass $5\frac{1}{2}$,, Wood ,,	2	0	10	4	6	1	4	1	4

WEIGHT and DIMENSIONS of LAND and SEA SERVICE MORTAR BEDS.—ENGLISH.

Nature of Bed.	Weight.			Dimensions.					
				Length.		Breadth.		Height.	
	Cwt.	Qrs.	lbs.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.
13 Inch Sea Service .... Iron..	83	2	8	7	2·5	4	7·5	3	3.5
13 Inch Land, Old pattern ,,..	48	3	11	5	8	3	4	2	1
13 Inch Land, New ,, ,,..	33	0	1	5	5·5	3	10·5	2	1
10 Inch Sea Service ....,,..	55	2	2	7	1	3	8	2	9·5
10 Inch Land, Old pattern ,,..	21	3	19	4	5	2	7	1	7
10 Inch Land, New ,, ,,..	16	1	16	4	4	3	4·5	1	7
8 Inch Land, Old ,, ,,..	11	1	10	3	6	2	1	1	3
8 Inch Land, New ,, ,,..	7	2	27	3	3	3	1	1	3
$5\frac{1}{2}$ Inch Land............. Wood..	1	0	10	2	7	1	3	0	9
$4\frac{2}{5}$,, ,,................ ,,..	0	3	0	2	5	1	3	0	8·5

The above weights of the Sea Service Beds, include the Pintails, each of which weighs 2 cwts. 2 qrs. 20lbs. and the breadth and length of each Bed for both Services, is measured from the extremities of the traversing bolts.

SARASWATI MAHAL

WHEELS.

What description of wheels are used in the Artillery Service?

At Madras one wheel is common to all light Field Carriages, Ammunition Waggons and Carts.

Diameter..........4 feet $11\frac{1}{2}$ inches.
Breadth of Tire.......... 3 inches.
Diameter of Brass Nave..13 inches.

One wheel is also common for heavy 18 and 12 pounders.

Diameter..........4 feet $9\frac{1}{2}$ inches.
Breadth of Tire... .... 6 inches,

The same wheel answers for both Carriage and Limber.

In the British Service the following sized wheels are used.

FIELD CARRIAGES.

The 12 pounder Gun limber, and waggon, 9 and heavy 6 pounder, $5\frac{1}{2}$ inch, and 24 pounder Howitzers. Take the heavy 6 pounder wheels. Diameter 5 feet, weight 4 cwt. 0 qrs. 26lbs. per pair.

The 9 and heavy 6 pounder limbers; light 6 and heavy 3 pounder Guns and limbers, $5\frac{1}{2}$ inch, and 24 pounder Howitzer limber; 12 pounder Howitzer and limber; and store and forge waggon. Take the light 6 pounder wheels. Diameter 5 feet, weight 3 cwt. 2qrs. 1lb. per pair.

The light 3 pounder and limber and $4\frac{2}{5}$ inch Howitzer and limber; diameter 4 feet 4 inches, 2 cwt. 0 qrs. 15lbs. per pair.

The Mountain Service Guns, Howitzers, and their limbers have all the same class of wheels; diameter 3 feet, weight 0 cwt. 3 qrs. 19lbs. per pair.

The ammunition and all other waggons, and carriages, have the same class of wheels, as the limbers of their respective Guns and Howitzers, &c.

HEAVY CARRIAGES.

24 pounder Gun and 10 inch Howitzer; diameter 5 feet, weight 8 cwt. 1qr. 10lbs. per pair.

18 pounder Gun and 8 inch Howitzer; diameter 5 feet, weight 6 cwt. 0 qr. 13lbs. per pair.

Limbers for the above; diameter 5 feet, 10 inches, weight 3 cwt. 2 qrs. 10lb. per pair.

PLATFORM CARRIAGE.

Fore, diameter 4 feet, weight 4 cwt. 2 qrs. 10lbs.

Hind, diameter 5 feet, weight 5 cwt. 2 qrs. 7lbs.

Devil Carriage, diameter 7 feet, weight 11 cwt. 0 qr. 24lbs. per pair.

Sling Cart, diameter 5 feet 6 inches, weight 8 cwt. 1 qr. 3lbs. per pair.

FLANDERS WAGGON.

Fore, diameter 4 feet 2 inches, weight 2 cwt. 3 qrs. 10lbs.

Hind, diameter 5 feet, weight 3 cwt. 2 qr. 1lbs.

Hand Cart, diameter 4 feet 4 inches, weight 2 cwt. 0qrs. 16lbs. per pair.

PONTOON CARRIAGE.

Fore, diameter 4 feet 2 inches, weight 2 cwt. 3 qrs. 20lbs.

Hind, diameter 5 feet 0 inch, weight 3 cwt, 2qrs. 1lb.

AMMUNITION.

What do you call Ammunition?

The charge of powder and projectiles of every description thrown from all kinds of Ordnance.

How is Ammunition conveyed on Field Service?

For heavy Ordnance, the powder is carried in barrels, generally on bullocks, the shot and shells in bags, on the same animals, or in carts according to circumstances.

Why does the Ammunition, for light Ordnance accompany it?

Because light Ordnance is always ready to open its fire, and prepared on the march to attack, or be attacked.

Why is not the Ammunition of heavy Ordnance carried with it?

Heavy Ordnance are seldom required except at a Siege, when time will always admit of the cartridge bags being filled as required; the powder also occupies less space in barrels, than when made up into cartridges.—The powder and shot are conveyed much cheaper on cattle or carts than in Ammunition waggons.

A few rounds made up should always accompany heavy Guns attached to a line.

What do you understand by fixed and unfixed Ammunition?

Fixed Ammunition is so called when the cartridge is tied to its shot, unfixed when separated from it.

Is the powder always in cartridges?

For Guns and Howitzers not for Mortars.

Why not for Mortars?

Because more nicety is required in regulating the charge for Mortars, it varies according to the distance and elevation.

Are cartridge bags never used for Mortars?

It has been experimentally ascertained the range is not affected, by the powder being loose, or in a bag, the

former mode is the usual way of loading Mortars, but is very objectionable from the accidents likely to happen from loose powder being carried about in a Battery while firing is going on. Bags are now getting into general use for Mortars, filled as required in the Expence Magazine.

Of what are cartridge bags made?

Of serge, or flannel for light Ordnance and of common cloth for heavy Ordnance.

Why made of serge for Field Ordnance and cloth for heavy Ordnance?

Because this kind of Ordnance is liable to fire quick, and serge does not retain fire in the manner cloth does, cloth is cheaper, and as heavy guns do not fire so rapidly as light ones, it is found sufficiently safe.

Why is serge of different colours used?

In red hot shot firing, coloured serge should always be used, the colouring matter fills up the interstices of the cloth, and thus prevents any of the powder dust falling out on its passage through the bore, which would be fired by the hot shot.

Why are cartridges not fixed to the shot?

In consequence of the accidents that have happened from waggons blowing up, caused by the shot and powder coming in contact, fixed Ammunition is abolished for all description of Ordnance.

How are cartridges carried with Field Ordnance?

The cartridges are carried in a copper cannister by themselves which fits into the centre locker of each ammunition box. This prevents almost the possibility of an accident by explosion, and in passing Rivers or other obstacles, the cannister with the powder can be taken out and conveyed safely across without getting wet.

Is much time lost in loading in consequence of the cartridge being separated from the shot ?	Little or none, the security gained much more than compensates for any trifling loss of time there may be.
How should the cartridge be put into the piece ?	With the tied end outwards ; if that end be next the vent, the surplus cloth and twine would very soon choak up the vent.
WHAT quantity of Ammunition is carried with a light 6 pounder at Madras.	72 Round shot. 18 Spherical case shot. 54 Cannister shot in one waggon with limber and gun limber.
How is it carried ?	In the Gun limber box. 21 Round shot. 6 Spherical case shot. 15 Cannister shot. In the waggon limber box. 21 Round shot. 6 Spherical case shot. 15 Cannister shot. In the three waggon boxes, all of the same size, each holding 20 rounds. 10 Round shot. 2 Spherical case shot. 8 Cannister shot.
WHAT is the total weight of a 6 pounder ammunition waggon filled including the limber ?	31 Cwt.
WHAT is the weight of an ammunition cart without limber filled ?	15 Cwt. 3 qrs.
WHAT is the total weight of a 6 pounder limber filled Gun or Waggon ?	14 Cwt. 3 qrs.

What quantity of Ammunition is carried with a 9 pounder at Madras?

72 Round shot.
54 Cannister shot.
18 Spherical case shot, in $1\frac{1}{2}$ waggon with limbers and gun limber.

In the gun limber box.

14 Round shot.
10 Cannister shot.
4 Spherical case shot.

In the waggon limber box.

14 Round shot.
10 Cannister shot.
4 Spherical case shot.

In the three Waggon boxes which are all of the same size, each holding 17 rounds.

8 Round shot.
6 Cannister shot (two over)
2 Spherical case shot.

Three waggons are allowed to two Guns.

What is the total weight of a 9 pounder Ammunition waggon filled including the limber?

30 Cwt. 2 qrs.

What is the total weight of a 9 pounder limber filled?

15 Cwt.

What quantity of Ammunition is carried with a 24 pounder Howitzer at Madras?

60 Shells common.
12 Spherical case shot.
20 Cannister shot.
4 Carcasses in two waggons with limbers and Howitzer limber.

How is it carried?

In the Howitzer limber box.

10 Shells common.
4 Spherical case shot.
2 Cannister shot.

In the waggon limber box.
10 Shells common.
4 Spherical case shot.
2 Cannister shot.
In the three waggon boxes all of the same size, each holding 8 rounds.
15 Shells common.
7 Cannister shot.
2 Carcass.

WHAT quantity of ammunition is carried with a 12 pounder Howitzer at Madras?

24 Round shot.
50 Shells common.
20 Spherical case shot.
48 Cannister shot.
4 Carcasses.
In two waggons with limber and Howitzer limber.

How is it carried?

In the Howitzer limber box.
12 Shells common.
2 Spherical case shot.
10 Cannister shot.
In the waggon limber box.
12 Shells common.
2 Spherical case shot.
10 Cannister shot.
In each of the three waggon boxes, all of the same size, each holding alike 12 rounds.
4 Ronnd shot
2 Shells common.
2 Spherical case shot.
3 Cannister shot.
1 Carcass.

WHAT quantity of ammunition is carried with a $5\frac{5}{8}$ inch medium Howitzer at Madras?

60 Shells common.
12 Spherical case shot.
20 Cannister shot.
4 Carcasses in two waggons with limbers and Howitzer limber.

How is it carried?

In the Howitzer limber box.
10 Shells common.
4 Spherical case shot.
2 Cannister shot.

In the waggon limber box.
10 Shells common.
4 Spherical case shot.
2 Cannister shot.

In each of the three waggon boxes, all of the same size, each holding alike 8 rounds.
15 Shells.
7 Cannister shot
2 Carcasses.

How much does an ammnnition cart carry?

Three boxes the same as the waggon without a limber.

For what purpose are ammunition carts used?

For the Park and Foot Artillery.

How many rounds are carried on service with an iron 18 pdr. at Madras?

1000 Round shot and 25 Cannister shot.

How many rounds are carried on service with an iron 12 pdr. at Madras?

1200 Round shot and 25 Cannister shot.

How many rounds are carried on service with a 10 inch Mortar at Madras?

No particular number laid down, from 2 to 300 common shells and 20 carcasses, a good proportion, also a few, say, 12 fire balls.

How many rounds are carried on service with an 8 inch Mortar at Madras.

400 Common shells.
20 Carcasses.
10 Fire balls.

How many rounds are carried on service with a 5½ inch Mortar at Madras?

500 Common shells.
20 Carcasses.
10 Fire balls.

How many rounds are carried with each nature of Ordnance in Europe?

See the following Tables extracted from the British Gunner.

18 *Pounder Gun Iron.*

Distribution.			Nature of Ammunition. Round shot	Case. Common	Case. Spherical	Total.
Waggon	Limber 2 Boxes		12	6	6	24
	Body...	Fore	9	0	6	15
		Hind	15	0	0	15
Total with Waggon			36	6	12	54
Reserve Waggons..		First	36	6	12	54
		Second	42	0	12	54
Total per Gun			114	12	36	162

Nine Waggons, per Battery of 3 Guns, carrying 162 rounds of ammunition per Gun.

Medium 12 *Pounder Brass.*

Distribution.			Nature of Ammunition. Round shot	Case. Common	Case. Spherical	Total.
Gun Limber, 2 Boxes			6	6	6	18
Waggon	Limber 2 Boxes		18	4	10	32
	Body...	Fore	18	0	6	24
		Hind	18	0	6	24
Total with Gun and Waggon			60	10	28	98
Reserve Waggon			54	4	22	80
Total per Gun			114	14	50	178

Ten Waggons, per Battery of 5 Guns, carrying 178 rounds of ammunition per Gun.

9 Pounder Brass.

Distribution.	Nature of Ammunition. Round shot	Case. Common	Case. Spherical	Total.
Gun Limber, Boxes	16	8	8	32
Waggon — Limber 2 Boxes	16	8	8	32
Waggon — Body... Fore	22	0	8	30
Waggon — Body... Hind	32	0	0	32
Total with the Gun and Waggon	86	16	24	126
Reserve — Two waggons for the 5 Guns	0	0	0	0
Reserve — Round Com. Sph. Total 140. 16. 32. 188. Per Gun	28	3	6	37
Total per Gun	114	19	30	163

Seven Waggons, per Battery of 5 Guns, carrying 163 rounds of ammunition per Gun.

Heavy 6 Pounder Brass.

Distribution.	Nature of Ammunition. Round shot	Case. Common	Case. Spherical	Total.
Gun Limber, 2 Boxes	30	10	10	50
Waggon — Limber 2 Boxes	30	10	10	50
Waggon — Body... Fore	40	0	10	50
Waggon — Body... Hind	50	0	0	50
Total with the Gun and Waggon	150	20	30	200
Reserve — One waggon for the 5 Guns	0	0	0	0
Reserve — Round Com. Sph. Total 120. 10. 20. 150. Per Gun	24	2	4	30
Total per Gun	174	22	34	230

Six Waggons, per Battery of 5 Guns, carrying 230 rounds of ammunition per Gun.

Light 6 Pounder Brass.

Distribution.			Nature of Ammunition. Round Shot.	Case. Common	Case. Spherical	Total.
Gun.	Axletree, 1 Box		3	3	0	6
	Limber, 2 Boxes		24	8	8	40
Waggon.	Limber 2 Boxes		32	8	8	48
	Body.	Fore	40	0	10	50
		Hind	50	0	0	50
Total with Gun and Waggon			149	19	26	194
Reserve.	One waggon for the 5 Guns		0	0	0	0
	Round Com. Sph. Total. 114 8 18 140	Per Gun.	22	1	3	26
Total per Gun			171	20	29	220

Six Waggons, per Battery of 5 Guns, carrying 220 rounds of ammunition per Gun.

Heavy 3 Pounder Brass

Distribution.			Nature of Ammunition. Round Shot	Case.	Total.
Gun....	Axletree, 1 Box		4	4	8
	Limber, 2 Boxes		50	20	70
Waggon	Limber 2 Boxes		50	20	70
	Body.	Fore	84	0	84
		Hind	84	0	84
Total per Gun			272	44	316

No reserve Waggons, 316 rounds of ammunition per Gun,

8 Inch Howitzer Iron.

Distribution.			Nature of Ammunition: Shells	Case: Common	Case: Spherical	Carcasses.	Total.
Waggon.	Limber, 2 Boxes		6	0	6	0	12
	Body.	Fore	3	0	5	3	8
		Hind	3	3	2	0	8
Total with Waggon			12	3	13	0	28
Reserve Waggons, 3 similar			36	9	39	0	84
Total per Howitzer			48	12	52	0	112

Four Waggons to each Howitzer, carrying 112 rounds of ammunition.

24 Pdrs. or heavy $5\frac{1}{2}$ Inch Howitzer Brass.

Distribution.			Nature of Ammunition: Shells	Case: Common	Case: Spherical	Carcasses.	Total.
Howitzer Limber, 2 Boxes			8	4	12	0	24
Waggon.	Limber, 2 Boxes		8	4	12	0	24
	Body.	Fore	8	0	8	2	18
		Hind	8	0	10	0	18
Total, with Howitzer and Waggon			32	8	42	2	84
Reserve Waggon			24	4	30	2	60
Total per Howitzer			56	12	72	4	144

Two Waggons to each Howitzer, carrying 144 rounds of ammunition.

12 *Pound Howitzer Brass.*

Distribution:	Nature of Ammunition. Shells.	Case Com.	Case Sphr.	Carcasses	Total.
Howitzer Limber, 2 Boxes	12	4	20	0	36
Waggon. Limber, 2 Boxes	12	4	20	0	36
Waggon. Body, Fore	12	0	12	4	28
Waggon. Body, Hind	12	0	16	0	28
Total, with Howitzer and Waggon	48	8	68	4	128
Reserve Waggon	36	4	48	4	92
Total per Howitzer	84	12	116	8	220

Two Waggons to each Howitzer, carrying 220 rounds of ammunition.

The flannel cartridges and small stores are distributed in the several boxes, in equal proportions with the above, according to circumstances.

HEAVY AND LIGHT FIELD ARTILLERY.

The following proportion of Ammunition and Stores, is established for each Piece of Ordnance, composing the Heavy Park, or Battering Train, and Light Field Artillery, at Madras.

The Battering Train consists of
Guns Iron........ 18 Pdr.
,, ,, ... 12 ,,
Mortars.......... 8 inch.
,, ... $5\frac{1}{2}$,,

Light Field Artillery consists of
Guns Brass.......... 9 Pdr.
,, ,, ... 6 ,,
Howitzers. 24 Pdr. and $5\frac{1}{2}$ inch medium.
,, ...12 Pdr. Howitzer.

N B.—Iron 24 Pdrs. and 10 inch Mortars are too unwieldy to be used on Common occasions; the latter Piece is sent to the different Stations for the purpose of proving Powder and Practice.

	Battering Train.				Light Field Artillery.				
	Guns.		Mortars.		Guns.		Howitzers.		
	18 Pdr.	12 Pdr.	8 Inches.	$5\frac{1}{2}$ Inches	9 Pdr.	6 Pdr.	Medium $5\frac{1}{2}$ Inches	12 Pdr.	
Ordnance..............	1	1	1	1	1	1	1	1	
Carriages complete Travelling..........	1	1	0	0	1	1	1	1	
,, Transport	1	0	0	0	0	0	0	0	One to each heavy gun 18 pounder.
Beds Mortar....	0	0	1	1	0	0	0	0	
Ammunition Waggons	0	2	0	0	$1\frac{1}{2}$	1	2	2	3 to two 9 pounders.
,, Carts...	0	0	0	0	$2\frac{1}{4}$	$1\frac{1}{2}$	3	3	$1\frac{1}{2}$ Cart to each waggon.
Carts Mortar....	0	0	0	0	0	0	0	0	One cart will carry two 8 inch or 4—$5\frac{1}{2}$ Inch.

	Battering Train.				Light Field Artillery.				
	Guns.		Mortars.		Guns.		Howitzers.		
	18 Pdr.	12 Pdr.	8 Inches.	$5\frac{1}{2}$ Inches	9 Pdr.	6 Pdr.	Medium $5\frac{1}{2}$ Inches	12 Pdr.	
Platform....	0	0	0	0	0	0	0	0	One Cart to 800 lbs.
Platforms Mortar....	0	0	1	1	0	0	0	0	
,, Gun.......	1	1	0	0	0	0	0	0	
Spare Carriage.... ..	0	0	0	0	0	0	0	0	
Carriages complete...	0	0	0	0	0	0	0	0	One to 2 heavy guns 12 pdr. 1 to 6 Heavy 18 pdr. 1 to each battery of Light Field Artillery 1 to 4 reserved light guns and Howitzers.
Beds Mortars....	0	0	0	0	0	0	0	0	One to two 8 inch and one to 4 — $5\frac{1}{2}$ inch.
Ammunition Waggons	0	0	0	0	0	0	0	0	One to each troop of Horse Artillery.
,, Carts...	0	0	0	0	0	0	0	0	One to each Foot Artillery battery.
Ammunition and Laboratory Stores.									
Shot Round..........	1000	1200	0	0	72	72	0	24	
,, Cannister.... ..	25	25	0	0	54	54	20	48	
Shells Common.......	0	0	400	500	0	0	60	50	
,, Spherical case filled..... ..	0	0	0	0	18	18	12	20	
Carcasses.............	0	0	10	10	0	0	4	4	
Fire Balls......... ...	0	0	20	20	0	0	0	0	
Cartridges Serge filled	20	20	0	0	144	144	96	146	$\frac{1}{4}$ Spare saluting, &c.
,, Empty or Spare..	30	30	0	0	36	36	24	36	
,, Cloth Empty	1100	1320	440	550	0	0	0	0	Including $\frac{1}{10}$ Spare.

,, Cloth filled bursting common shells. ..	0	0	440	550	20 3½ oz.	20 2½ oz	70 12 oz. / 13 6 oz	62 8 oz / 22 4½ oz	,, $\frac{1}{10}$ Spare powder taken from Barrels as required.
Gunpowder L. G. 100 lb. Barrels	B lb. 61 50	B lb 49	B lb 12 90	B lb. 6 62½	B lb. 3 25¾	B lb. 2 19⅛	B lb. 2 49⅜	B lb. 2 19¾	Total barrels including the filled cartridges for Light Field Artillery.
,, S. G lbs. Barrels..	30⅔	36⅔	0	0	6 lbs.	6 lbs.	6 lbs.	6 lbs.	Priming, &c.
,, Mealed lbs	1	1	1	1	1	1	1	1	
Fuzes Common drove	0	0	800	1000	0	0	120	100	2 to each common shell.
,, Spherical Case drove.........	0	0	0	0	36	36	24	40	2 per shell.
Match Cotton sks.	6	6	6	6	2½	3	3	3	12 yards in a skain, 1 yard burns 1½ hours.
,, Quick........,,	¼	¼	12	12	1	1	1	1	One skain about 60 rounds—40 yards.
,, Country .. .. ,,	4	4	4	4	0	0	0	0	
Portfires..................	50	50	0	0	60	60	30	40	Match generally used with heavy ordnance.
Oakum lbs.	0	0	0	0	85½	57	114	114	50 lbs. per waggon and limber, and 7 per gun limber.
Adze Copper..........	0	0	0	0	0	0	0	0	One to every 500 barrels of powder.
Axe Felling..........	1	1	0	0	0	0	0	0	One to each piece ¼ spare not included.
,, Pick...............	1	1	0	0	1	1	1	1	
Augers Fuze Brace..	0	0	0	0	1	1	1	1	1 to each Piece light ordnance in the small store box.
,, Hand ..	0	0	0	0	1	1	1	1	The same number for a brigade.
Axletrees Heavy Fleid	0	0	0	0	0	0	0	0	1 spare to 6 heavy carriages.
,, Light	0	0	0	0	0	0	0	0	1 spare to 6 carriage and ammunition waggons.
,, Platform									
,, Cart......	0	0	0	0	0	0	0	0	1 spare to 12 carts.
Buckets Tar..........	1	1	0	0	2	2	3	3	1 to each limber.
,, leather water	1	1	0	0	1	1	1	1	One to each gun ¼ spare not included.

	Battering Train.				Light Field Artillery.				
	Guns.		Mortars.		Guns.		Howitzers.		
	18 Pdr.	12 Pdr.	8 Inches	$5\frac{1}{2}$ Inches	9 Pdr.	6 Pdr.	Medium $5\frac{1}{2}$ In.	12 Pdr.	
Bits Steel...........	2	2	1	1	2	2	2	2	
Boxes dredging.........	0	0	1	1	1	1	1	1	One to each gun and howitzer.
,, Tube with 50 tubes..........	0	0	0	0	1	1	1	1	} Carried in the small store box light ordnance.
,, Quick Match .	0	0	1	1	1	1	1	1	
,, Fuze with 30 Fuzes S.C.Shot	0	0	0	0	1	1	1	1	
Budge Barrels.......	0	0	0	0	0	0	0	0	One to 3 mortars with carriages not required.
Coins Upper..........	0	0	1	1	0	0	0	0	
,, Under.........	0	0	1	1	0	0	0	0	
Compasses Common..	0	0	1	1	1	1	1	1	Carried in the small store box the same number to a brigade.
,, Caliber....	0	0	0	0	1	1	1	1	
Cylinders tin loading.	0	0	1	1	0	0	0	0	
Cloth waxed Cubits..	2	2	2	2	2	2	2	2	
Copper Bottle Spirits of Wine...........	0	0	0	0	1	1	1	1	Carried in the small store box, the same number to a brigade.
Chains retreating.....	0	0	0	0	1	1	1	1	Carried under the limber.
Drivers and Setters ..	0	0	1	1	1	1	1	1	And one spare, setter to each mortar.
,, Copper......	0	0	0	0	0	0	0	0	One for every 500 barrels of powder.
Engines Fuze........	0	0	0	0	0	0	0	0	One to 5 mortars.
Esses Iron............	2	2	1	1	2	2	2	2	Two to each 4 wheel'd carriage.
Fellies....	2	2	0	0	2	2	2	2	

Files 3 square..........	0	0	0	0	0	0	0	0	One to each saw.
Funnels small..........	1	1	1	1	1	1	1	1	
Gin complete..........	0	0	0	0	0	0	0	0	One to 6 heavy pieces.
Hammers Claw..........	1	1	1	1	2	2	3	3	One to each limber.
Hambro line, Sks..........	1	1	1	1	1	1	1	1	
Handpikes Traversing	2	2	0	0	1	1	1	1	¼ spare for heavy field and ½ light field to be carried in the park.
,, Gin..........	0	0	0	0	0	0	0	0	¼ do. do. do. do.
,, Purchasing	4	4	4	4	2	2	2	2	Spare ¼ this number to be carried in the park.
Haversacks leather..........	3	3	0	0	2	2	3	3	Spare ¼ of the whole number in the Battery to be carried in the Park.
Horns Priming..........	1	1	0	0	0	0	0	0	
Hooks Bill..........	1	1	0	0	2	2	3	3	¼ spare not included, one to each limber.
Jack Hand..........	0	0	0	0	0	0	0	0	One to every 4 guns or mortars.
Knives Laboratory..........	1	1	1	1	1	1	1	1	Carried in the small store box.
Ladles with worms..........	1	1	0	0	1	1	1	1	Screw wadd hook better to fix in the rammer head has been recommended one to each piece ¼ spare not included.
Linstocks with Cocks.	1	1	1	1	1	1	1	1	
Locks pad with keys.	0	0	0	0	10	7	12	12	
Mamoties..........	1	1	0	0	1	1	1	1	
Marline Sks..........	1	1	1	1	1	1	1	1	¼ Spare not included.
Match Box..........	0	0	0	0	1	1	1	1	Fixed to each light field carriage.
Needles..........	3	3	3	3	3	3	3	3	Carried in the small store box.
Portfire Cutter..........	0	0	0	0	0	0	0	0	One to each carriage fixed.
Perpendiculars..........	0	0	0	0	0	0	0	0	One to every 2 mortars, or each single mortar.
Pincers Common..........	1	1	0	0	1	1	1	1	Carried in the small store box.
,, Fuze..........	0	0	1	1	1	1	1	1	

	Battering Train.				Light Field Artillery.				
	Guns.		Mortars.		Guns.		Howitzers.		
	18 Pdr.	12 Pdr.	8 Inches	5½ Inches	9 Pdr.	6 Pdr.	Medium 5½ In.	12 Pdr.	
Portfire Stocks......	1	1	0	0	1	1	1	1	¼ Spare not included, carried in the small store box.
Pouch priming........	2	2	0	0	2	2	3	3	One to each limber ¼ spare carried in the park.
Priming Irons........	2	2	2	2	2	2	2	2	¼ Spare not included.
Punches Tube........	0	0	0	0	1	1	1	1	
Pole bars Horse Artillery..............	0	0	0	0	0	2	0	0	One to each limber.
Quadrant Spirit........	0	0	0	0	0	0	0	0	One to every 4 mortars or each single mortar.
Rasps Fuze...........	0	0	1	1	1	1	1	1	Carried in the small store box.
Reliever Spring Spike	1	1	0	0	1	1	1	1	
Rope Europe .. Fms.	6	6	0	0	1	12	18	18	6 Fathoms per limber.
,, Drag......Setts.	1	1	0	0	2	2	3	3	One to each limber ¼ spare not included
Spunge Common.......	2	2	2	2	2	2	0	2	¼ Spare not included.
,, Concave........	0	0	0	0	1	1	2	1	
Saws Fuze............	0	0	0	0	1	1	1	1	One to every 2 mortars, carried in the small store box.
Setters Saw...........	0	0	0	0	1	1	1	1	One to each saw, carried in the small store box.
Scales Copper with weights 4 lb. ..setts.	0	0	0	0	0	0	0	0	One sett to every 2 mortars, or to each single mortar.
Scissars,........Pairs.	1	1	1	1	1	1	1	1	Carried in the small store box.

Spare. Spunge Staves. ..	1	1	1	1	0	0	0	0	
Head. Spunge..	2	2	0	0	2	2	2	2	
Head. Rammer.	2	2	0	0	0	0	0	0	
Keys. Keys....	2	2	0	0	0	0	0	0	
Keys. Rings...	2	2	0	0	0	0	0	0	
Liuch pins........	2	2	0	0	1	1	2	2	
Washers.........	2	2	0	0	1	1	2	2	
Scale Gunter........	0	0	0	0	1	1	1	1	Carried in the small store box.
Spunyarn...... Rolls	2	2	0	0	1	1	2	2	
Spokes.......	2	2	0	0	2	2	2	2	2 to each 4 wheeled carriage—1 to each cart.
Spikes round........	1	1	0	0	1	1	1	1	¼ Spare not included.
,, ragged........	1	1	0	0	1	1	1	1	
,, spring.........	1	1	0	0	1	1	1	1	
Tar and Grease. Kegs.	2	2	0	0	1	1	2	2	1 to each waggon light ordnance.
Tarpaulins..........	0	0	0	0	3	3	5	5	
Traces Chain........	1	1	1	1	1	1	1	1	¼ Spare not included.
Twine..........Sks.	2	2	2	2	2	2	2	2	
Vices bench..........	0	0	1	1	1	1	1	1	Carried in the small store box.
,, Copper........	0	0	0	0	0	0	0	0	One to every 500 barrels of powder.
Wadds...............	0	0	0	0	0	0	0	0	One to 10 rounds, the remainder made up on the spot as required.
Wrench..............	1	1	0	0	1	2	2	2	One to each limber.
Yokes Pole..........	0	0	0	0	2	2	3	3	¼ of the whole not included.
,, Trace........	1	1	0	0	10	8	12	12	
,, Pole quadruple	1	1	0	0	0	0	0	0	
,, Trace.........	8	6	0	0	0	0	0	0	

CHARGES.

WHAT do you call the charge of a piece of Ordnance?	The Powder with which it is loaded.
HAVE all Guns a fixed charge?	Yes, $\frac{1}{3}$ the weight of the shot for Iron Guns, and $\frac{1}{4}$ for Brass Guns, in this proportion the powder is estimated; lesser charges are sometimes used but seldom greater.
WHEN are lesser charges used?	In ricochet firing.
WHEN are greater charges used?	In breaching occasionally at very short distances.
ARE heavy charges advantageous?	No; the charge should never be greater than necessary to effect the desired object; but on service, with Field Pieces, time will not admit of the cartridges being reduced or encreased, while actually firing, so one general principle has been laid down. In the same manner is estimated the quantity of powder for heavy Ordnance, a general charge for which has also been established which is seldom exceeded.
WHAT are the disadvantages of heavy charges?	The Carriages are much shaken, the piece itself becomes more heated, and the metal liable to run particularly at the vent, or burst, and there is a greater expenditure of Gunpowder than necessary.
WHY have Iron Guns a larger charge than Brass Guns?	Because they are intended to make breaches, where greater force is required than firing against men or small defences.
Is the present established charge considered the best?	No, these charges have been fixed upwards of 50 years, since which period powder has much improved in

strength, and the windage has been much reduced, by encreasing the size of the shot, consequently the charge of powder should also be reduced.

At Madras the charge established for 9 pounders differs from the general principle, being only 2 lbs.

Is the same charge used from the same piece with all kinds of Ammunition?

Yes, from Field pieces with round, cannister and spherical case shot; also from Iron Guns generally.

Is no increase or reduction made according to the strength of Powder?

At Madras when the Powder exceeds 1400 yards proof, $\frac{1}{5}$ is deducted, and $\frac{1}{6}$ when 1200 yards proof.

WHAT is the charge for scaling Guns?

See the Table at the end of this Article.

WHAT is the charge for proving Guns?

See the Table at the end of this Article.

WHAT is the charge for saluting?

See the Table at the end of this Article.

WHAT is the charge for Carronades?

Service charge $\frac{1}{12}$ the weight of the shot, the highest charge $\frac{1}{8}$ and the lowest $\frac{1}{16}$.

WHAT is the Service charge for Howitzers?

This must depend on the distance and object in view.

The quantity the chamber will hold is the usual estimation for each shell, both for the charge and filling the shell.

How is the quantity of powder calculated for Mortars on Service?

The charges for Mortars vary also, the usual proportion is $\frac{2}{3}$ the chamber full for each shell, probably the chamber full for shell and charge, would be sufficient and more simple.

The following Table gives the charges for all kinds of Ordnance, extracted from the latest English Gunner.

Nature of Ordnance.			Charges. Proof. lb	oz	Service. lb	oz	Saluting. lb	oz	Scaling. lb	oz
Guns.	Iron.	130 Pounder or 10 Inch Gun 68 Pounder	14	0	7	0	0	0	2	0
		42 ,,	25	0	14	0	10	8	3	0
		32 ,,	21	8	10	11	8	0	2	12
		24 ,,	18	0	8	0	6	0	2	0
		18 ,,	15	0	6	0	4	0	1	8
		12 ,,	12	0	4	0	3	0	1	0
		9 ,,	9	0	3	0	2	0	0	12
		6 ,,	6	0	2	0	2	0	0	8
	Brass.	12 ,, Medium	5	0	4	0	3	0	0	12
		12 ,, Light	4	0	3	0	3	0	0	8
		9 ,,	3	8	3	0	0	0	0	0
		6 ,,	3	0	2	0	2	0	0	8
		6 ,,	2	0	2	0	2	0	0	8
		6 ,, 5 Feet	2	0	1	8	1	0	0	4
		3 ,,	1	8	1	0	1	0	0	4
		3 ,,	1	0	1	0	0	8	0	2
		1 ,,	1	0	0	6	0	6	0	2
Howitzers.	Iron	10 Inch	14	0	7	0	0	0	0	0
		8 ,,	8	0	4	0	0	0	0	0
	Brass.	24 Pounder	3	0	2	8	0	0	0	0
		12 ,,	1	8	1	4	0	0	0	0
		$5\frac{1}{2}$ Inch	3	0	2	0	0	0	0	0
		$4\frac{2}{5}$,,	0	8	0	8	0	0	0	0
Carronades.		68 Pounders	13	0	5	10	5	10	2	0
		42 ,,	9	0	3	8	3	8	1	8
		32 ,,	8	0	2	10	2	10	1	6
		24 ,,	6	0	2	0	2	0	1	0
		18 ,,	4	0	1	8	1	8	0	12
		12 ,,	3	0	1	0	1	0	0	8
		6 ,,	1	8	0	12	0	12	0	6

At Madras the following are the service charges of powder from 1000, 1200, *to* 1400 *yards proof.*

	Proof 1000 yards.		Proof 1200 yards.		Proof 1400 yards.	
	lb	oz	lb	oz	lb	oz
Iron Guns 24 Pdr.	8	0	6	11	6	7
,, ,, 18 ,, ...	6	0	5	0	4	13
,, ,, 12 ,, ...	4	0	3	6	3	4
Brass Guns 9 Pdr.	2	0	1	11	1	10
,, ,, 6 ,, ...	1	8	1	4	1	3
,, ,, 3 ,, ...	0	12	0	10	0	$9\frac{1}{2}$
,, Howr. 24 ,, ...	2	0	1	11	1	10
,, ,, 12 ,, ...	1	4	0	14	0	13
,, ,, Med. $5\frac{1}{2}$ Inches .	2	0	1	11	1	10

At 1200 yards proof $\frac{1}{6}$ is deducted, and at 1400 yards $\frac{0}{5}$.

Powder for Bursting Shells.

	lb.	oz.
10 Inch.........	2	10
8 ,, ...	1	14
$5\frac{1}{2}$,, ...	0	12
$4\frac{2}{5}$,, ...	0	8

CARTRIDGES

FOR

SMALL ARMS.

How many Blank cartridges will a sheet of paper make?	Sixteen Musket; twenty-four Fuzil.
How many Ball cartridges will a sheet of paper make?	Twelve Musket; sixteen Fuzil.
How much powder in a Blank cartridge?	Four Drams Musket; three Fuzil.
How much powder is allowed for a Ball cartridge?	Six Drams Musket; five Fuzil.
Why is blue paper used for Blank, and white for Ball cartridges?	To prevent mistakes, that one may not be served out for the other, which has happened.
How many cartridges are tied in a bundle?	Ten.
How are cartridges carried on Service?	In small Barrels or Boxes; on Bullocks generally, sometimes in waggons.
How many cartridges will a Bullock carry?	1000 Ball.
How many in each Barrel?	500 Ball.
How many in each Box?	500 Ball.
How many cartridges will an expert hand make in one day?	600 Ball, or 1200 blank Muskets, or Fuzil.

How many Musket Balls to 1lb. of lead?	$14\frac{1}{2}$, or 29 to 2lbs.
How many Pistol Balls to one pound of lead?	Twenty.
WHAT quantity of materials are required to make 1000 Musket cartridges?	Powder lb $23\frac{11}{16}$—Paper quires $4\frac{6}{24}$---Twine Europe $2\frac{1}{16}$ oz.---Twine Country skein $9\frac{1}{8}$ oz.
WHAT quantity of material are required to make 1000 Pistol cartridges?	Powder lb. $15\frac{3}{4}$—Paper quires $3\frac{11}{24}$—Twine Europe skein $2\frac{1}{16}$ oz.—Twine Country skein $6\frac{1}{4}$ oz.

Cartridges Blank and Ball for Small Arms--Ordnance Regulations, Madras.

		POWDER.		CARTRIDGES.					FORMER.			
	Lead Balls to 1 lb.	Weight in one Cartridge:	One lb: makes Cartridges.	One sheet of paper makes.	One skein of Bengal twine ties.	One skein of Europe twine ties.	In one bundle.	One Barrel contain.	Length.		Diameter.	
	No.	Drs:	No.	No	Bundles.	Cartridges.	No.	No.	Inches.	Pts.	Inches.	Pts.
Musket Ball.........	$14\frac{1}{2}$	6	$42\frac{4}{5}$	12	580	1300	10	500	9	0	0	67
,, Blank	0	4	64	16	700	0	0	800	9	0	0	67
Fuzil Ball............	20	5	$51\frac{1}{5}$	16	580	0	0	500	8	0	0	60
,, Blank	0	3	$83\frac{1}{3}$	24	700	0	0	1000	8	0	0	60
Pistol Ball...........	20	4	64	16	580	0	0	550	7	80	0	60
,, Blank...........	0	2	128	24	680	0	0	1000	7	80	0	60

Allowance for waste or loss—1 lb. of Gunpowder for every 100 pounds.—Paper 1 Sheet for every 50.

General Table of Small Arm Cartridges in England.

NATURE OF ARM.	Charge for Service. Drs.	Charge for Proof. Oz.	Charge for Proof. Drs.	Charge for Exercise. Drs.	Number packed in each. Bundle	Number packed in each. Box.	Weight of Box. Empty. lb.	Weight of Box. Empty. oz.	Weight of Box. Filled. lb.	Weight of Box. Filled. oz.	Weight of Cartridge. lb.	Weight of Cartridge. oz.	Dimensions of Former's. Diameter. Inches.	Dimensions of Former's. Hollow. Inches.	Dimensions of Former's. Length. Inches	Number in each Sheet.	Dimensions of Papers. Longest side. Inches.	Dimensions of Papers. Breadth. Inches.	Dimensions of Papers. Shortest. Inches.	Number made by a Man or Boy in a day.
Musket	6	1	7½	5	10	1000	12	4	106	3	93	13	·65	·2	5·25	12	7·15	5·3	3·75	400
Carbine { Common	4	0	15	4	10	1300	12	4	98	3	85	10	·59	·18	5·9	16	6·0	5·15	2 6	400
Carbine { Musket bore ...	5½	0	0	4½	10	1080	12	4	109	10	97	4	·65	·2	5·25	12	7·15	5·3	3·75	400
Rifle	4	0	0	4	10	1300	12	4	98	5	85	10	·59	·18	5·9	16	6·0	5·15	2·6	400
Pistol { Carbine bore ...	3	0	0	3	10	1500	12	4	106	15	94	8	·59	·18	5·9	16	6.0	5·15	2·6	400
Pistol { Musket bore ...	3½	0	0	3	10	1350	12	4	123	14	111	8	·65	·2	5·25	12	7·15	5·3	3·75	400

PROJECTILES.

What are projectiles? — By projectiles is understood any kind of Shot or Shell or any other body thrown from a piece of Ordnance.

SHOT.

How many kinds of shot are there in common use? — Round shot, cannister shot, spherical case shot, and tier shot.

What is a shot? — A solid metalic spherical body.

What are round shot made of? — Cast Iron.

As lead is much heavier, why are they not made of that metal? — The lead is so much more expensive and so liable to get out of shape from its softness.

What examination do shot undergo before they are sent on service? — The rust is first beat off them, they are then passed through a flat brass ring called a gauge, of exactly the size the shot should be, those that are too large and cannot pass through it, should be rejected, as they would stick in the Gun, and not be driven home; on the other hand, those that are very small should be rejected, or the greater part of the charge would escape by the windage, and the shot would be driven from side to side in the bore, so that no dependence could be placed in its direction when out of the Gun as it naturally would be driven in a contrary direction to the part where it last struck the bore, either to the right or left, up or down,

A tube of a foot in length for the shot to roll through would be better than the common gauge.

How are shot usually carried on Service?

For Field Pieces in the Limber and Waggon, for heavy Guns, commonly loose in gunny Bags on Bullocks proportioned to the weight the animal can travel with

How are shot usually kept in Magazines?

In piles, each row decreasing by one, till the top row consists of one only: they are piled in three different shapes, triangular, square and rectangular.

How is the number in a triangular pile ascertained?

Multiply the base plus 1, this product by the base plus 2, and divide by 6.

How is the number in a square pile ascertained?

Multiply the bottom row by the bottom row plus 1, and this product by twice the bottom row plus 2, and divide by 6.

How is the number of shot in a rectangular pile ascertained?

Multiply the breadth of the base by itself plus 1, and the product by 3 times the difference between the length and breadth of the base, added to twice the breadth plus 1, and divide by 6.

How is the number of shot in an incomplete pile found?

Incomplete piles being only frustrums, wanting a similar small pile on the top, compute first the whole pile as if complete, and also the same pile wanting at top and then subtract the one number from the other.

The simplest method of computing any complete pile, whether square, rectangular or triangular, is, by multiplying the sum of the three parallel ridges, by $\frac{1}{3}$ of the number of shot in the triangular face, the three parallel ridges of a square pile, are

the two exterior rows of the base and the top shot, the axis of which is parallel to the others.

In a rectangular pile the two exterior rows of the base lengthwise and the top ridge, in a triangular pile, the exterior base row on any side, the opposite shot at the angle, and the top shot;—the number of shot in the triangular face is found by multiplying the number of shot in the base row of that face plus 1, by half the number in the base row.—When the shot in the triangular face will not divide by 3, the sum of the three parallel ridges invariably will; thus keeping in mind which are the three parallel ridges you have a general rule for complete piles.

Is there any means of ascertaining the dimensions and weight of shot without instruments?

Yes, by means of an experimented weight of a ball of a given size, from the known proportion of similar figures, nearly as the cubes of their diameter.

How do you find the weight of an iron ball from its diameter?

An iron ball of 4 inches diameter weighs 9lbs, and the weights being as the cubes of their diameters, it will be as 64 (the cube of 4) is to 9, so is the cube of the diameter of any other ball to the weight.

How do you find the diameter of an iron ball?

Multiply the weight by $7\frac{1}{9}$ and the cube root of the product will be the diameter.

How do you find the diameter of a leaden ball from its weight?

The weight multiplied by 9 being divided by 2, the cube root of the quotient will be the diameter.

How do you find the weight of a lead-

A leaden ball of $4\frac{1}{4}$ inches diameter, weighs 17lbs, therefore as the

en ball from its diameter?

cube of $4\frac{1}{4}$ is to 17 (as 9 to 2 nearly); so is the cube of the diameter of the leaden ball to its weight.

From what description of Guns and on what occasions are red hot shot used?

From battering Guns, in fixed situations, and garrisons, to fire buildings, &c.

How hot should the shot be made?

To wafer red, if heated more the shot would become brittle, and break to pieces, against any hard substance they may strike.

How long are shot heating?

Heating the furnace takes from half to three quarters of an hour; when once heated, the shot upon an average will be from 15 to 20 minutes attaining the required degree of heat.

How much do shot expand when heated to the required degree?

Not so much as to prevent their entering their respective Guns.

What precautions are necessary in loading with hot shot?

The cartridge is put home gently with the spunge head, which will bring out any particles of Powder that may have fallen out in the bore, a high dry junk wad over it, then a high soaked wad, which should be squeezed till not a drop of water can be forced out, the Gun being elevated one degree the shot is put in the muzzle and will roll home, being previously cleared of any dirt or scales that may adhere to it; a low soaked wad is set home on the shot.

How is the shot in its heated state taken to the Gun?

The shot with an iron rake is placed on the *carrier* consisting of an iron ring not large enough for it to fall through attached to two branches with a wooden handle to each: two men take the carrier by the handles and

carry it to the muzzle, and let the shot roll in.

Is it necessary to fire the piece immediately the shot is in?

No, it has been experimentally ascertained that the shot will get cold in the Gun, without burning through more than a few threads of the wet wad.

Do shot exactly fit the piece?

No, rather smaller, the difference is called the windage which is one twentieth of the calibre.

WHY are they made smaller than the bore of the piece?

To allow them to be easily rammed home on the cartridge.

In firing hot shot, the iron expands, and if of the exact size of the bore, they would not fit.

DOES any ill effect result from the shot not exactly fitting the piece?

Yes, the powder when reduced by explosion to a fluid, flies quicker than the shot, and what thus passes it in the bore is lost, having no effect on it; in the old proportion of windage $\frac{1}{3}$ or $\frac{1}{4}$ of the charge of powder was supposed to be lost.

How are shot preserved from the effects of the atmosphere particularly near the Sea?

They should be coated with thin lacker.

WHAT are the dimensions of round shot?

See the following table.

Dimensions of Round Shot for Guns, Howitzers, & Carronades.

	Nature of Ordnance.	Diameter of Bore.	Maximum.		Founder's Limit.	Difference between diameter of Bore, and		
			Existing.	Proposed.		Maximum.	Medium.	Minimum.
		Inches	Inches	Inches.	Inches	Inches	Inches.	Inches.
Carronades.	68 Pounder..	8 05	7·95	7·85	1	1	·15	·2
	42 ,, ...	6 84	6 795	6·729	·066	·045	·178	·111
	32 ,, ...	6 25	6 207	6 147	·06	·043	·073	·103
	24 ,, ...	5·68	5·639	5·584	·055	·041	·0685	·096
	18 ,, ...	5·18	5·124	5·075	·05	·036	·061	·086
	12 ,, ...	4 52	4·476	4 432	·044	·044	066	·088
	9 ,, ...	4·14	4 1	4·06	·04	·04	·06	·08
	6 ,, ...	3·6	3·568	3·532	·036	·032	·05	.068
Guns.	68 Pounder..	8·05	7 95	7 85	·1	·1	·15	·2
	42 ,, ...	7·018	6·795	6·729	·066	·223	·256	·289
	32 ,, ...	6·41	6 207	6 147	·06	·263	·233	·263
	24 ,, ...	5·823	5·639	5·584	·055	·184	·211	·239
	18 ,, ...	5·292	5 124	5·074	·05	·168	·193	·218
	12 ,, ...	4·623	4 476	4·432	·044	·147	·169	·191
	9 ,, ...	4·2	4 1	4·06	·04	·1	·12	·14
	6 ,, ...	3 668	3·568	3·532	·036	·1	·118	·136
	4 ,, ...	3 204	·	·	·	·	·	·
	3 ,, ...	2·913	2 833	2·803	·03	·08	·095	·11
	1 ,, ...	:	1 955	1·913	·	·	·	·
Howitzers.	10 Inch	10·0	9·88	9·8	·08	·12	·16	·2
	8 ,, ...	8·0	7·95	7·85	·1	.05	·1	·15
	5½ ,, ...	5·62	5·62	5·57	·05	·	·0025	·05
	4⅖ ,, ...	4·52	4 476	4·432	044	·044	·066	·088
	24 Pounder	5·66	5·62	5 57	05	·021	·0485	·09
	12 ,, ...	4·52	4·476	4 432	·044	·044	·066	·088

CASE OR CANNISTER SHOT.

WHAT do you call case or cannister shot?	A number of small balls, put into a cylindrical tin cannister, a plate of iron at each end, that at the bottom being thicker than the top, which is of sheet iron with a cord handle to lift the case by, and at the same time to distinguish it from the bottom.—The tin case is made to correspond with the calibre of the piece.
WHY have case shot iron bottoms, will not wood answer as well?	With iron bottoms, the small balls are not so soon scattered, they bodily receive the first impulse of the charge of powder while in the piece, as the bottom is not destroyed by the explosion, in consequence the effect is nearly doubled; wooden bottoms are blown to pieces by the explosion and the powder acts individually on the small balls, drives them against each other, and the sides of the piece.—At 600 yards the range with iron bottoms is as effective from a 6 pdr. as at 300 yards with wooden bottoms.
Do iron bottoms cut and score the gun?	No,—it was supposed they did, but from numerous experiments it has been proved they do not, unless by carelessness they are put in with the bottom *outwards* instead of being *next the powder*; to prevent this, the bottom is painted black and the case red, a handle is also fixed to the top.
WHY is the bore injured when the bottom is outward?	The fluid, instantly on explosion destroys or forces in the thin top, passes among the small balls, and acting on the bottom irregularly from this cause, forces it against the side

of the piece, which is thereby cut and scored.

The edges should be rounded to prevent this as much as possible.

What difference is there in weight, between case and round shot of the same calibre?

They should be nearly equal as possible, the round shot generally has the advantage of a few ounces. In the Royal Artillery two kinds of cannister shot are used for field Guns, heavy and light; the heavy weighs nearly half as much again as its round shot for short distances; we use two cases instead.

From what pieces of Ordnance, are cannister shot usually thrown?

From all kinds of Guns, heavy and light; Howitzers, and occasionally from Mortars in vertical fire.

What sized balls are used from case shot?

At Madras 2 and 3 ounce balls only; have lately been established for field pieces; the 2oz for the 6 and 9pdrs., and 12 pdr. Howitzers; 3oz. for $5\frac{1}{2}$ inch, and 24 pdr. Howitzer.

For what particular service is case shot required?

To fire at masses of troops at short distances; from the number in a case, more execution will be done within its range, than by a single ball.

The balls separate and spread from the instant they quit the piece.

At what distance should case shot be fired?

Not beyond 5 or 600 yards, the resistance of the air to them, will prevent their flying much farther with effect—their spread will also be very great.

Is it any consequence how the balls are placed in the cannister?

No,—experience has shewn it is not, nor filling the interstices with rosin or dammer; an idea was formerly entertained that by these means, the balls would range closer and farther, but experiments shew there is no decided difference.

What is the difference between grape, and case shot?

Grape shot so called from resembling a bunch of grapes in shape: the small balls are placed round a spindle in the centre of the bottom inclosed in a canvas bag and quilted.

Why are case shot better than grape?

Because the case is more expeditiously filled, and in travelling the balls rust and destroy the canvas bags and twine with which they are quilted, a defect case shot is not subject to.

Grape shot are completely exploded in Land Service but are still used at Sea.

Of how many balls do case shot consist, and what is the total weight of the case?

See the Table below.

NATURE OF ORDNANCE.	Shot. Weight. lbs.	Shot. Weight. oz.	Shot. Weight. dr.	Shot. No. in each.	Tampeons or Bottoms. Iron. Thickness. In.	Iron. Diameter. In.	Iron. Weight. lbs.	Iron. Weight. oz.	Iron. Weight. drs.	Wood. Thickness. In.	Wood. Diameter. In.	Wood. Weight. lbs.	Wood. Weight. oz.	Wood. Weight. drs.	Cases. Circumference. In.	Cases. Depth. Between the Clips. In.	Cases. Depth. Total. In.	Cases. Weight. lbs.	Cases. Weight. oz.	Cases. Weight. drs.	Total Weight. lbs.	Total Weight. oz.	Total Weight. drs.
ENGLISH.																							
Guns. Field Service. 12 Pdr.	..	2	..	126	05	4.25	..	2	8	1. 1	4.25	..	..	..	14 4	7. 7	8.8	..	11	..	7	6	8
	..	6	8	41	.05	4.25	..	2	8	1. 1	4.25	..	..	..	14.4	7.63	8 7	..	13	..	5	9	..
9 ,,	..	1	8	126	.05	4. 0	..	2	.	1. 0	4. 0	..	..	..	13 2	7. 3	8.4	..	9	..	12	11	..
	..	5	..	41	05	4. 0	..	2	..	1 0	4. 0	..		..	13.2	7. 0	8.0	..	9	8	13	4	..
6 ,,	..	1	8	85	05	3. 5	..	1	8	98	3. 5	..	..	..	11.5	6 7	7 7	..	8	..	8	12	..
	..	3	4	41	05	3. 5	..	1	8	98	3. 5	..	..	..	11 5	6. 1	7.2	..	7	..	9	..	..
3 ,,	..	1	8	41	.05	2. 7	..	.	12	.79	2. 7	..	..	..	9.1	4 8	5.8	..	4	..	4	5	.
Howitzers. 10 Inch	..	8	..	170	06	9 7	..	13	..	..	.	..	..	..	31 7	8. 9	9.4	2	1	..	86	4	..
8 ,,	..	2	..	285	.05	7. 6	..	8	8	..	7. 8	..	..	..	24.8	7 6	8 6	..	14	.	35	..	..
5½ ,,	..	2	..	100	.05	5. 3	..	4	..	1.29	5. 3	..	..	..	18.1	4. 5	5 7	..	7	..	14	..	..
4⅖ ,,	..	2	..	55	.04	4.25	..	2	..	1. 1	4.25	..	..	..	14 4	3 7	4 8	..	4	8	7	11	8
24 Pdr.	..	2	..	140	.05	5. 3	..	..	..	1.29	5. 3	..	..	..	18.1	5. 5	6.5	..	..	.	19	4	..
12 ,,	..	2	..	84	.04	4.25	..	..	..	1. 1	4 25	..	..	..	14·4	5. 2	6 2	..	..	..	11	13	..
Carronades. Case. 68 Pdr.	..	8	..	90	06	7. 6	..	..	..	1.45	7 6	1	6	4	24.5	7 7	8 9	1	4	..	46	9	..
42 ,,	..	8	..	66	.05	6 45	..	..	..	1.35	6.45	1	..	12	21 6	7. 9	8.9	1	2	..	32	8	8
32 ,,	.	8	..	40	05	5. 9	..	..	..	1. 0	5. 9	..	7	4	19.3	5 9	7.0	..	11	4	21	4	..
24 ,,	..	8	..	32	.05	5. 3	..	..	..	.85	5. 3	..	6	8	17 9	5. 8	6.8	..	10	8	16	1	..
18 ,,	..	6	..	31	.05	4 75	..	..	..	. 8	4.75	..	6	6	15 8	5 7	6 6	..	7	4	12	2	..
12 ,,	..	4	..	32	.04	4.25	..	..	..	.75	4.25	..	4	6	13.8	4. 4	5.5	..	5	12	8	2	..
Carronades. Grape. 68 Pdr.	3	..	..	15	..	7. 6	..	..	..	1.45	7. 6	1	6	4	24.7	....	9.2	..	..	..	..	..	..
42 ,,	4	..	.	9	..	6 45	..	..	..	1.35	6.45	1	.	12	21.3	...	9.8	..	..	..	..	..	..
32 ,,	3	..	..	9	..	5. 9	..	..	..	1. 0	5 9	..	7	4	19 2	....	9 0	..	..	..	..	..	..
24 ,,	2	..	..	9	..	5. 3	..	..	..	.85	5. 3	..	6	8	17.4	....	7 8	..	..	..	..	..	..
18 ,,	1	8	..	9	..	4 75	..	..	..	. 8	4.75	..	6	6	15.8	.. .	6 9	..	..	..	..	..	..
12 ,,	1	..	..	9	..	4.25	..	..	..	.75	4.25	..	4	6	13.9	....	6.5	..	..	..	..	..	..
MADRAS.																							
New Pattern. How. 24 Pdr.	..	3	..	90	. 3	5. 2	1	14	..	..	..	..	..	..	17.0	6. 0	7.0	..	6	8	18	4	..
12 ,,	..	2	..	84	.25	4. 2	1	..	..	..	..	..	..	..	13 6	5. 5	6.5	..	5	8	12	8	..
Guns. 9 ,,	..	2	..	58	.25	4. 0	..	14	..	..	..	..	..	..	12.6	5. 5	6.5	..	5	8	9	3	..
6 ,,	..	2	..	43	.25	3. 4	..	9	..	..	..	..	..	..	11.1	5. 0	6.0	..	4	..	6	3	..

The weights and dimensions of the Cases in this Table apply to the new Pattern Case-Shot, introduced into the Service by Major General Millar of the Royal Artillery. The depth of the old pattern cases is generally four or five tenths of an inch less than the above,

SPHERICAL CASE SHOT

OR

SHRAPNELL'S SHELLS.

What do you call spherical case shot?

Spherical case shot differ from common case shot by the balls being put into an iron shell, with a small charge of powder, which is made to explode at any required distance by means of a fuze, in the same manner as a common shell, when the small balls and the splinters of the shell proceed and complete the curve in which the shell was proceeding at the time of its explosion; the shells are not so thick as common ones; the following Table gives the dimensions with the number of balls in each.

Table of the dimensions of Spherical Case Shot, the number of Musket, Carbine and Pistol Balls each will hold, and weight when filled.

Nature of Shells.	Balls.			Weight of Shells.				Shells.		Powder for bursting.
	Musket.	Carbine.	Pistol.	Empty.		Filled.		Diameter	Thickness of Metal.	
	No.	No.	No.	lb.	oz.	lb.	oz	Inches	Inches	oz.
8 Inch..	377	525	525	31	.	58	6	7.75	7	15
32 Pounde	176	240	240	14	12	27	4	6.16	.6	7
24 ”	130	180	180	11	.	20	.	5 5	.55	6
18 ”	90	135	135	8	6	14	12	5 05	.475	5
12 ”	63	86	86	5	9	10	2	4.4	.4	$4\frac{1}{2}$
9 ”	41	60	60	4	11	7	10	4.	.375	$3\frac{1}{8}$
6 ”	27	37	37	3	.	4	15	3.55	.35	$2\frac{1}{2}$
3 ”	11	.	.	1	8	2	3	2.84	.25	$1\frac{1}{2}$

Why are these shot called Shrapnell's shells?

Because they were invented by Colonel Shrapnell of the Royal Artillery.

Why are leaden balls used?

The balls must be very small to enter at the fuze hole, and if made of iron they would not be sufficiently heavy to do execution.

What advantage have spherical over common case?

In the distance they can be thrown; the case or shell with the leaden balls inside it, ranges as far as common shot, and after it bursts, the balls will proceed from 150 to 200 yards with effect.—The resistance of the air to the small balls in common case shot which are exposed to it individually, almost immediately on leaving the muzzle, from the bursting of the tin cannister, considerably diminishes their range; within range of common case, it is superior to spherical case, as there is no uncertainty of the case not bursting, which there is with the latter, from a bad fuze, and other causes.

What are considered the best sized balls to fill shells with?

Musket balls, smaller have little or no effect, and larger cannot pass through the fuze hole.

How are balls put into the shells?

The shell is half filled with balls, a stick of hard wood is then applied into the fuze hole to pack them, then put in a few balls, and the stick alternately, until the shell becomes perfectly well filled, and choaked below the fuze hole; none of the balls to remain in the fuze hole; the stick to be of strong hard wood about 12 or 15 inches long, as the diameter of the shell may require, and turned in the form of a skewer, nearly to fill the fuzehole.

How is the charge of powder put in ?

The bursting powder is poured through a funnel into the fuze hole, shaking the shell in order to receive it, no powder is to remain in the fuze hole.

Is it necessary to uncap the fuze and dredge it, before it is put into the Gun ?

Yes, or the priming would not be ignited by the explosion, because they are made nearly to fit the piece, having very little windage, not so much as a round shot.

How is the shell put home without the fuze being injured or the dredging knocked off ?

The head of the spunge is made with a concavity for the purpose.

Is it usual to prepare these shot previous to marching, and fix the fuzes ?

No, the leaden balls are put in the case, and a cork or plug in the fuze hole.—The charge is put in small bags, in the copper box, with the other powder ; when an attack is apprehended the fuzes are then fixed and every thing prepared, this operation takes very little time: A few in the limber box should be carried prepared, when there is the least chance of an attack. If the powder be put in the shells, in travelling, the grains would from the friction of the balls be reduced to dust.

TIER SHOT.

What do you call tier shot?

Tier shot differ from case shot, in being larger, and placed in the case in regular layers or tiers; in the Royal Artillery it appears they are used with Field Guns, see the table at the end of this article.

Tier shot called also "new pattern grape shot" are used in the Navy.

It consists of 9 shot with 4 cast iron plates connected by a spindle that passes through the lower plate and is rivetted above the upper one with a nut, the two centre plates have six holes through each, for the balls: in the other two the holes do not go through but sufficiently deep to allow the balls torest in them.

Three balls are placed between each plate.

Are tier shot preferable to case shot?

No, at Madras experiments were made to ascertain this point, it was given in favor of common case shot with iron bottoms

Of what sized balls are tier shot made?

See the following tables.

Tier Shot for Field Service.

		oz.	No.	lb	oz.
12 Pounder	Medium	18	15	18	8
		6½	42	17	11
6 Pounder	Medium	8½	15	9	0
		3½	42	8	14
3 Pounder	Medium	4½	15	4	10
		1½	42	4	6
12 Pounder	Light	14	12	14	14
		6½	34	14	11
6 Pounder	Light	8½	12	7	3
		3½	34	7	7
3 Pounder	Light	4½	12	3	10
		1½	34	3	11

Table of New Pattern Grape Shot with 4 Iron Plates, Pin, Nut and 9 Shot.

Nature.	Length of Grape.		Diameter of Plates.		Weight of each Shot.		Weight of 9 Shot.		Weight of Plates, Pin and Nut.		Total Weight of the Grape.	
	in.	ten.	in.	ten.	lb.	oz.	lb.	oz.	lb	oz.	lb	oz.
32 Pounder......	9	0	6	1	2	12	24	12	9	0	33	12
24 „	7	6	5	5	1	13	16	5	7	12	24	1
18 „	6	7	5	0	1	6	12	6	5	9	17	15
12 „	6	2	4	1	0	15	8	7	3	11	12	2
9 „	5	7	4	0	0	13	7	5	2	7	9	12
6 „	4	7	3	5	0	8	4	8	1	12	6	4

SHELLS.

What is a shell?	A hollow iron ball made sufficiently strong as not to be destroyed by the explosion of the charge of the piece, from which it is thrown, with a hole to receive the fuze.
How are shells distinguished?	In the same manner as Mortars by their diameter, in inches.
FROM what pieces of Ordnance are they usually thrown?	From Mortars and Howitzers commonly,—sometimes from Guns.
For what purpose are shells intended?	To break through and fire buildings, also to destroy troops, by the number of pieces into which they burst.
WITH what are shells usually filled?	There must be a sufficient quantity of powder to burst them. Shells intended to fire magazines, buildings, &c. are usually filled up with pieces of portfire, tar, rocket composition, and all kinds of combustible matter, the fiercer and slower it burns the better. Shells thrown against troops, have powder only in them, and should contain the quantity that will break them into the greatest number of pieces or splinters; the quantity is not exactly known, but supposed to be about $\frac{2}{3}$ of what the shell will contain; if filled, the shell will only break into two or three pieces.
Is the thickness of metal of the shell, the same throughout?	Yes,—formerly the bottom was made thicker than the sides, on the supposition it would first come to the ground, and ensure the fuze being uppermost, and thus prevent its being injured by the fall, or put out by being

under most should the shell fall in mud, or soft ground; but experience has shewn that this will not prevent the fuze first coming in contact with the ground, and that when the shell is of the same thickness throughout it bursts into a greater number of pieces than when there is a thicker bottom.

Why have some shells handles or lugs and others not?

Very large shells cannot be lifted without a crane or hooks, and handles are consequently necessary to fasten the hooks to; small shells do not require them, as they can be lifted by hand and let into the Mortar by being placed on a bearing leather, or by tying a string round the head of the fuze.

When should a shell burst?

If intended to fire buildings, not until it has struck its object; if it does not burst till some time on the ground, the fuze may be put out and the shell would be useless;—if against troops when a few yards over them.

How is the fuze placed?

Outside towards the muzzle, if next to the powder it would be destroyed by the explosion, and the shell would burst in the piece.

As the fuze is towards the muzzle how is it fired?

By the explosion of the charge in the piece, which flies much quicker than the shell itself, and passes all around it and thus lights the fuze, which is well dredged with mealed powder to ensure its catching fire.

How much of the fuze should project out of the shell?

The less the better, not more than the cup, the more that is exposed, the greater will be the action of the air on it, and of course the more chance of the shell being driven out of its direction.

How are shells usually employed against Troops?	Thrown a ricochet with small charges and low elevations, from Howitzers; shells thus bounding along with burning fuzes, are very apt to make the enemy unsteady and waver, particularly Cavalry Horses.
Are shells ever used in breaching?	Yes; with great effect, a few thrown into the breach occasionally; and there bursting will have the same effect as a small Mine in clearing away the rubbish and throwing down the wall.
How are shells proved?	Shells are first examined as to their dimensions and weight, an empty fuze is then driven into the fuze hole, and the shell is suspended in a tub of water, in such a manner that it is covered by the water, but that it does not run into the fuze hole, several strong puffs are then given with a pair of bellows, and if no bubbles arise in the water, the shell is concluded to be serviceable.
How do you ascertain the number of shells in a pile?	In the same manner as shot, which see.
How do you find the weight of a shell?	Take nine sixty-fourths of the difference of the cubes of the external and internal diameters, for the weight of the shell.
How do you find the quantity of powder that will fill a shell?	Divide the cube of the internal diameter of the shell in inches, by 57.3 for the pounds of powder.
How do you find the size of a shell to hold a given quantity of powder?	Multiply the pounds of powder by 57·3, and the cube root of the product will be the diameter in inches.

What shells fit Guns, that is, can be fired from them?

Hand Grenades from, 6 Pounder,
$4\frac{2}{5}$ Shells ,, 12 ,,
$5\frac{1}{2}$,, ,, 24 ,,
8 inch 68 Pdr. Carronades.

Can a shell be thrown from a piece of Ordnance when too large to enter the bore?

Yes, for this purpose, the Gun may be elevated to any degree that will retain the shell upon its muzzle, which may be assisted by a small line going from the lugs of the shell round the neck of the Gun.

To produce a greater effect, the space between the shell and the charge should be filled with wads, oakum, &c.

WEIGHTS AND DIMENSIONS OF SHELLS FOR HOWITZERS AND MORTARS.

Nature of Ordnance.	Diameter.			Thickness of Metal.	Proposed.		Founder's Limit.	Difference between diameter of Bore and			Weihgt.			
	Of Bore.	Fuze Hole. Exterior.	Fuze Hole. Interior.		Maximum.	Minimum.		Maximum.	Medium.	Minimum.				
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Cwt	Qr.	lb	Oz.
13 Inch........	13·0	1·84	1·7	2·1	12·88	12·8	.08	.12	.16	.2	1	3	4	0
10 ,, ...	10·0	1·61	1·5	1·6	9·88	9·8	.08	.12	.16	.2	0	3	11	0
8 ,, ...	8·0	1·22	1·13	1·3	8·95	7·85	.1	.05	.1	.15	0	1	13	3
5½ ,, ...	5·62	0·9	0·84	0·85	5·62	5·57	.05	.0	.025	.05	0	0	15	0
4⅖ ,, ...	4.52	0·82	0·77	0·7	4·476	4·432	.044	.044	.066	.088	0	0	7	8
24 Pdrs	5·66	0·9	0·84	0·85	5·62	5·57	.05	.04	.065	.09	0	0	15	0
12 ,, ...	4·52	0·82	0·77	0·7	4·476	4·432	.044	.044	.066	.088	0	0	7	8

CARCASSES.

WHAT is a carcase ?

A carcase is made of iron, and differs only from a shell in having three or four fuze holes instead of one.

WHAT is the use of a carcase ?

To set fire to buildings.

WHY have carcasses more than one fuze hole?

Carcasses are not intended to burst like shells, the fuze holes are to allow the fire of the composition with which they are filled to rush out, the more holes from which it can escape, the more chance there is of its firing whatever it comes in contact with. They can be made to burst if necessary by increasing the charge of powder.

DOES it signify in what part of the carcase the holes are made ?

Yes, they should not be made in that part that comes in contact with the charge of powder, or the explosion would destroy them.

WITH what composition are carcasses filled ?

That which burns fiercest, is least likely to be put out, and slow in consuming is the best. The following is the common composition.

Saltpetre 6 pounds, 4 ounces ; sulpher 2 pounds, 8 ounces ; antimony 10 ounces ; rosin, 1 pound, 14 ounces ; tallow 10 ounces ; turpentine 10 ounces.

The dry parts of the above proportion of ingredients must, previously to being mixed, be pulverized, and then thoroughly incorporated by rubbing them between the hands, and afterwards passing them three or four times through a hair sieve. The

oil is next boiled, and the dry ingredients added to it, in small quantitiesat a time, stirring it all the time of putting in, till the whole proportion is mixed. In about a quarter of an hour the composition is generally ready for use.

TABLE of WEIGHTS and DIMENSIONS of CARCASSES.

	Nature of Carcasses.	Diameter	Weight Empty.				Composition.		Weight filled.			
		Inch.	cwt.	qrs.	lbs.	oz.	lbs	oz.	cwt.	qrs.	lbs.	oz.
Land Service.	13 Inch	12·84	1	2	27	0	17	14	1	3	16	4
	10 ,,	9·85	0	3	6	4	7	4	0	3	13	8
	8 ,,	7·85	0	1	20	0	2	14	0	1	22	14
	42 Pounder	6·85	0	1	0	14	1	12	0	1	2	10
	32 ,,	6 10	0	0	23	$3\frac{1}{4}$	1	$4\frac{1}{2}$	0	0	24	8
	24 ,,	5·54	0	0	15	6	1	$3\frac{1}{2}$	0	0	16	$9\frac{1}{2}$
	18 ,,	5·04	0	0	13	12	0	$11\frac{1}{2}$	0	0	14	7
	12 ,,	4·4	0	0	8	6	0	7	0	0	8	13
Sea.	13 Inch	12·85	1	3	17	12	14	8	2	0	4	5
	10 ,,	9·85	0	3	13	0	6	6	9	3	19	6

FIRE OR LIGHT BALLS.

What are fire or light balls?	They are in shape similar to carcasses, but the case is made of paper, and have the same number of fuze holes.
What is the use of a fire or light ball ?	To discover what the enemy are about in a dark night, at a siege, so that their working parties may be discovered and Guns brought to bear on them —They can also be used for firing buildings, but being made of paper, they would not be able to break through roofs like iron ones.
With what composition are light or fire balls filled ?	Saltpetre 6 pounds, 5 ounces; sulphur 2 pounds, 8 ounces; rosin, I pound, 14 ounces, and linseed oil, 7 ounces, 8 drachms.
How is the composition mixed ?	In the same manner as carcass composition.

DIMENSIONS OF FIRE BALL CASES.

Nature of Ball.	Diameter. Interior.	Diameter. Exterior.	Thickness of Case.	Diameter of Fuze. Exterior.	Diameter of Fuze. Interior.
	Inches	Inches	Inches	Inches	Inches
10 Inch	8·6	9·75	1·15	1·57	1 45
8 „	6·65	7·75	1·1	1·325	1·227
5½ „	4·75	5·54	·79	·894	·826
4⅖ „	3 75	4·4	·65	·832	·769

LABORATORY.

WHAT do you understand by an Artillery Laboratory?

The place where all kinds of composition, in which gunpowder or its ingredients forms a part, is mixed, and the articles made, such as portfires, fuzes, tubes, match, rockets, fireworks of every description, cartridges filled, &c. &c.

MIXING COMPOSITION.

WHAT are the ingredients for fuze and portfire composition?

Saltpetre, sulphur and charcoal.

In what state are the ingredients when placed in the mixing troughs?

Refined.

Do the ingredients bear the same proportion to each other, for fuze and portfire composition?

No, fuze composition is made to burn much faster than portfire, and contains more charcoal.

WHAT are the proportions for fuze composition?

Saltpetre 35lbs., sulphur 12lbs. and charcoal 3lbs.

WHAT are the proportions for portfire composition?

Saltpetre 44lbs, sulphur 14lbs and charcoal 1lb.

DESCRIBE the process of mixing?

In mixing fuze composition, the saltpetre is rolled 3 hours by itself, the sulphur is mixed with it and rolled 2 hours, the charcoal is then put in, well mixed with the hands, and the whole moistened with clean water and rolled 3 hours more.

Portfire composition is rolled in the same manner, but in half the time.

How do you judge when the mixture is proper?

It is properly mixed when you cannot discern any particles of saltpetre or sulphur.

Is fresh charcoal considered the best for these mixtures, or will it not answer equally as well, if kept a long time in store?

Experience shews, the fresher the charcoal is, the better will be the composition in which it enters.

Should composition be worked up soon after mixed, or may it be kept any considerable time without injury?

Composition will keep good for 3 months, but answers better if drove while new.

Of what is rocket composition made?

Saltpetre, sulphur, and charcoal.

Describe a mixing?

It is mixed in the same time and manner as portfire composition, and is always used damp.

What proportion do the ingredients bear to each other?

Hollow part;—saltpetre 4lb. 4oz.—sulphur 1lb.—charcoal 1lb. 8oz.—Solid part;—saltpetre 1lb—sulphur 4oz.—charcoal 6oz.—mealed powder 2lbs.

TABLE OF PROPORTIONS:

	Saltpetre.		Sulphur.		Charcoal.		Mealed Powder.		Total.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Fuzes..........	8	12	3	0	0	12	0	0	12	8
Portfires.........	11	0	3	8	0	4	0	0	14	12
Rocket hollow part	4	6	1	0	1	8	0	0	6	14
,, solid ,,	1	0	0	4	0	6	2	0	3	10

The above is one mixing of each composition.

PORTFIRES.

WHAT is a portfire and its use?	A paper cylindrical tube, filled with composition driven hard. Its use, to fire the priming of pieces of Ordnance.
How much paper will make a case?	One and a quarter sheet.
How long is the case?	Twenty-one inches.
WHAT is the diameter?	Eigth-tenths of an inch.
WHAT is the diameter of the hollow part?	Four-tenths of an inch.
How many cases will a man roll in a day?	Seventy.
WHAT quantity of materials make 100 cases?	Portfire paper 5 quires and 5 sheets, flour 1 measure.
How much composition does a ladle hold?	Two drams.
How many blows are given to each ladle of composition?	Twenty.
How do you judge when the composition is driven sufficiently hard?	No impression should be made on it when scratched by the finger nail; when broken asunder the composition should be equally firm as at the end and not crumble.
WHAT would be the effects of a portfire carelessly driven that is, not the same	The part not properly driven would be softer than the other, and the fire would there be more rapid than in the other part, and probably burst the

number of blows to each ladle of composition? — case, at all events it would burn quicker than the paper case.

How can you ascertain whether a portfire has been properly driven or not? — By inspection,—take a few out of a large number, cut them open longitudinally when the ladles not regularly driven, will be softer than the others, or in dust as the case may be.

What security have you that the men driving them are attentive, as it is impossible they can be always overlooked? — The name of the man who rolled the case, also that of him who filled it, and the respective dates, is written on the case.

How long should a portfire burn, and what is its length when driven? — Sixteen inches in length, should burn nearly as many minutes; the size of a portfire is arbitrary, the above has been found most convenient.

Should the paper case of a portfire burn with the composition? — Yes, otherwise there would be left a void between the burning composition and the end of the case, in consequence the fire will not be so intense below, and not ignite the priming so soon; this is a difficult point to attain; the men are obliged constantly to be rubbing the portfire against the ground, to break off the case below the fire.

Should a portfire burn in water? — Yes, for a short time, no rain however violent should be able to put it out.

Are there any objections to the use of portfire on Service? — Yes, in the dark the strong light they give, point out to the enemy the position of the Artillery, and draw their fire on it.

Why are portfires then used? — Because no quicker mode of firing Guns is known, or in use.

TABLE OF PORTFIRES.

Weight of						Composition in one mixing.				Length			Diameter			Driving.					Drifts.							
																Ladle.			Mallet.		1st.		2d.		3d.			
Case empty.		Composition in one.		A bundle, or ten drove and packed.		Saltpetre.	Sulphur.	Charcoal.	Total.	Empty.	Drove.		Case.	Composition.	Paper in one Case.	Composition in one.	Blows to each.	Will fill 1 portfire.	Weight of		Length.	Diameter.	Length.	Diameter.	Length.	Diameter.	Time of burning.	One man will drive in a day.
oz.	drs.	oz.	drs.	lbs.	oz.	lbs.	lbs.	lbs	lbs.	Ins.	Ins.	ten.	ten.	ten.	sheets	drs.	No.	No.	lbs.	oz.	Ins.	ten.	Ins.	ten.	Ins	ten.	min.	No.
2	6	3	12	3	4	11	3½	¼	14¾	21	16	5	8	4	1·25	2	20	30	1	8	24	3·5	18	3·5	12	3·5	16	40

FUZES.

What is a fuze?

A wooden tube decreasing in size, from the head downwards, with a cylindrical cavity down the centre, from the large end to within about half an inch of the small end.

A groove is marked round the bottom of the cup *outside*, similar circles in the same way from it to the end of the bore or cylindrical cavity, at 2-10ths of an inch apart.

What is the use of a fuze?

To set fire to the powder in a shell, by means of the composition with which the cylindrical cavity is filled.

Why does a fuze decrease from the head downwards?

Because it is only required to fit the thickness of metal at the fuze hole of a shell. It is easy to rasp it down to the proper size at the head, that below the metal of the fuze hole, is of no consequence, but if made of the same size throughout, the whole would require to be reduced to make it fit and consequently cause much useless trouble.

For what purpose is the cylindrical cavity down the centre of the fuze?

This is filled with composition, by means of which the powder in a shell is set on fire.

Why is not the end hollowed in the same manner as the rest?

The end is left solid for two reasons, that the composition may not be exposed to the influence of the atmosphere and thereby injured; also, because it is necessary to have a hard substance to drive against in filling the fuze, so as to get the composition to a proper consistency.

Why is the head or large end called the cup, hollowed in the shape of a bowl ?	To receive a priming consisting of quick match and mealed powder, to ensure the explosion of the Mortar igniting the fuze composition.
What are the circles cut on the exterior surface of the fuze for ?	The upper one at the bottom of the cup, to shew where the composition commences, the lower one where it ends, the intermediate ones, for the convenience of cutting the fuze, to any required length, without the trouble of having recourse to a scale and a pair of compasses.
What is the length and diameter of each nature of fuze, both of case and composition ?	Vide " Fuze Table."
Why are fuzes made of wood, will nothing else answer ?	Wood has not only been found better than metal as it does not corrode the composition, but can by means of a rasp be much easier reduced to any required size.
Is it necessary a fuze should be of any particular length ?	A fuze is not required to be longer than the interior diameter of the shell, added to the thickness of the metal at the fuze hole.
Is there any particular thickness for the wood round the composition ?	It should be so thick as not to split in driving in the composition, and the top fit the fuze hole.
How is the cup secured to prevent the contents falling out, and the composition from being injured ?	A circular piece of paper the same size as the top of the fuze is laid on the priming, this is covered with a larger piece pasted down the sides as low as the first circle, when dry, the head of the fuze is dipped in kitt.
Is there any difference between fuzes for common shells and	Only in the priming, in spherical case shot fuzes, spirits of wine is mixed with mealed powder and forms

those for spherical case shot ? a paste, the quick match is also drawn through four holes, perforated at right angles through the cup. In common shells the priming is dry mealed powder and quick match.

Why is there this difference ? In consequence of the low angles at which S. C. S. are usually thrown, and the length of the Gun ; if the priming was dry, it would fall out in the bore before the shell is put home.

This cannot happen in a short piece, as a Mortar, and at the high angles at which they are usually fired.

In the event of the priming getting injured from exposure or other cause, is it necessary to condemn the fuze, or can the priming be replaced ? The priming can be easily replaced by shaking it out and adding fresh quick match, and priming powder, or moistening the old priming with any kind of spirits.

Is there any particular time a certain length of fuze should burn ? All fuzes should burn equal lengths in equal times, otherwise no calculation could be made with regard to the length required for a certain distance.

All fuzes made at the Artillery Depôt, burn alike, 1 inch in 5 seconds or ⅕th of an inch in one second.

How are fuzes driven to ensure their burning equally ? A certain number of blows are given to each ladle full of composition, these blows should be given with equal force, and the ladle should contain the same quantity of composition always.

How do you ascertain this has been done, as you cannot see the composition through the fuze ? Take a few out of a lot, cut them at different lengths, and if they burn regular, it is a fair supposition the rest are driven in the same manner ; another way is, to saw a fuze through the

composition longitudinally, then by inspection it will be ascertained whether each ladle has been equally driven, if not some part will be harder than the others, and the fire of course will not burn with equal force, and thus destroy the proportion.

As a check on the Laboratory men at the Depôt, the initials of the man who drives the fuze is marked on it.

To what consistency should the composition be driven?

When sawed through, it should not crumble; by scratching with the finger nail, no impression should be made on it.

How many blows to each ladle of composition?

Twenty to the large and fifteen to the small fuzes.

Should fuze composition when driven, be moist or quite dry?

Quite dry.

Why is the drift moved after every blow?

To prevent its sticking in the composition, also to lessen the danger of explosion, and to ensure the whole ladle of composition being equally driven.

TABLE OF FUZES.

	Weight of Fuze.						Composition for mixings.							Length			Diameter.								Capping		
																	Outside.								Quick Match.		
	Empty.		Composition in one.		One drove and capped for Service.		Saltpetre.	Sulphur.	Charcoal.	Total.	Men employed.	Hours in mixing.	Will fill.	Of wood.	Composition.		Head.		Bottom.		Composition.		Fuze hole of Shell.		Length.	Thread.	A Skein will cap.
	oz.	drs.	oz.	drs.	oz	drs.	lbs.	lbs.	lbs.	lbs.	No.	No.	No.	Inches.	Inches.	Tenth.	Inches.	Tenth.	Inches.	Tenth.	Inches.	Tenth.	Inches.	Tenth.	Inches	No.	No.
Common 13 Inch	5	9	1	2	6	13	35	12	3	50	8	8	711	6	5	..	2		1	5	.	4.	1	8	3	2	70
,, 10 ,,	3	10	1	2	4	12	35	12	3	50	8	8	711	6	5	..	1	7	1	3	..	4.	1	6	3	2	80
,, 8 ,,	2	7	1	2	3	10	35	12	3	50	8	8	711	6	5	..	1	3	0	9	..	4.	1	2	3	2	90
,, 5½ ,,	0	13	0	6	1	8	35	12	3	50	8	8	2133	5	4	..	1	0	0	7	..	2.5	0	9	2	2	120
,, 4⅖ ,,	0	12	0	5	1	3	35	12	3	50	8	8	2560	4	3	..	0	9	0	7	..	2.5	0	8.5	2	2	120
Spherical Case Sho 8 ,,	0	9¾	0	6	1	0	35	12	3	50	8	8	2133	2	1	5	1	3	0	9	..	4.	1	2	3	2	90
,, ,, ,, 5½ ,,	0	9½	0	2	0	10	35	12	3	50	8	8	6400	2	1	5	0	9.5	0	8	..	2.5	0	8.7	2	2	120

TABLE of FUZES.

	Dammering.								Driving.														
									Ladle.			Mallet.		1st Drift.		2d Drift.		3d Drift.				
	Wax.	Pitch.	Rosin.	Total quantity.		Portfire Paper.	Flour.	Will cap.	Composition in each.	Blows to each.	Will fill a fuze.	Weight of		Length.	Diameter.	Length.	Diameter.	Length.	Diameter.	Diameter of boring augur.	Time of burning.	One Man will drive in a day.
	lbs.	lbs.	lbs.	lbs.	oz.	Sheets.	Meas.	No.	Drs.	No.	No.	lbs.	oz.	Inches	Tenth.	Inches.	Tenth.	Inches.	Tenth.	Tenth.	Secds.	No.
Common 13 Inch	1	1	4	6	..	17	1	400	1.5	20	12	1	8	7	3.5	5	3.5	3	3.5	4	25	70
" 10 "	1	1	4	6	..	20	1	500	1.5	20	12	1	8	7	3.5	5	3.5	3	3.5	4	25	70
" 8 "	1	1	4	6	..	15	1	600	1.5	20	12	1	8	7	3.5	5	3.5	3	3.5	4	25	70
" 5½ "	1	1	4	6	..	12	1	800	.5	15	12	0	14	6	2	4.5	2	3	2	2.5	20	120
" 4⅖ "	1	1	4	6	..	12	1	800	.5	15	10	0	14	4.5	2	3.5	2	3	2	2.5	15	150
Spherical Case Shot 8 "	1	1	4	6	..	15	1	600	1.5	20	4	1	8	3.5	3.5	2.5	3.5	..	..	4	7.5	120
" " " 5½ "	1	1	4	6	..	12	1	800	.5	15	4	0	14	3.5	2	2.5	2	..	..	2.5	7.5	250

THE TANJORE MAHARAJA SERFOJI'S SARASWATI MAHAL.

TUBES.

What is a tube ?	A hollow cylindrical pipe, with a cup at one end, about 3 or 4 inches in length.
What is the use of a tube ?	To communicate fire to the charges of Guns.
Of what are they generally made ?	Of metal—copper or tin, or of reeds or quills.
Which kind are considered the best ?	Reeds or quills.
Why ?	Metal is found to corrode the composition with which they are filled ; besides, when rather large for the vent they sometimes stick instead of flying out at the explosion, and cause much delay in clearing the vent.
What are the dimensions of tubes ?	The diameter should be somewhat less than that of the vent of a Gun which is $\frac{2}{10}$ of an inch, that they may freely enter. Four inches have been found sufficiently long to fire any piece.
With what are tubes filled ?	With quick match, sometimes with mealed powder and spirits of wine made into a paste.
How is the quick match drawn through the tube ?	A piece of brass wire with a loop at one end, is inserted through the tube, the match is put through the loop and drawn through double.
How are tubes capped ?	The cup is filled with spirits of wine and mealed powder, made into paste, and a piece of thin cloth called *bittelass* tied over with a clove hitch, the cup is dipped in spirits of wine and mealed powder made very thin.

WHEN injured by keeping, can tubes be recovered?

Generally, by recapping them, or drawing out the quick match and putting in new.

DOES the cloth cover over the cup require being removed previous to firing?

No, the mealed powder and spirits of wine so impregnates it, that this precaution is unnecessary.

How do you prevent reed or quill tubes from falling into the vent of guns?

A head may be made by twisting twine round it, till too large to enter the vent; but the most common and expeditious method is to fasten a piece of brass wire round the head of the tube, and allow enough to project on each side to prevent its falling into the piece.

MATCH.

QUICK.

Of what is quick match composed?

Cotton thread, soaked in mealed powder and spirits of wine.

What is the use of quick match?

To communicate fire to any combustible matter rapidly, generally used for priming mortars, fuzes, and filling tubes.

What proportion are the three ingredients to each other?

Cotton thread 4 ozs; mealed powder 3lb.; spirits of wine 2 quarts.

Describe the process of a mixture?

A skein of thread is wound into balls some of 2, 3, and 4 threads each, as many balls as will make the number of threads required for the match are wound into one, weighing 4 oz., which is placed in a copper pan and well soaked with spirits of wine and mealed powder, it is then unwound into another pan, taking care to place it so as not to ravel when reeled on the frame after boiling; the end of the match is made fast to a piece of wood, the mealed powder is strewed over the thread, and the spirits of wine poured in, the thread is then pressed lightly with the hands until the ingredients are thoroughly mixed, it is put over a slow fire, and kept simmering till the liquor is nearly evaporated, which will be in 21 minutes, the pan is taken off and the match reeled upon the frame, passing through a man's hand full of mealed powder moistened with the liquor remaining after boiling; dry mealed powder is sifted over

the match, which is then put out in the sun to dry.

WHAT is the usual size of quick match? Sufficiently small to pass through the vent of a piece of Ordnance.

SLOW.

WHAT is slow match, and what is its use? Slow match in India is made of common white cotton rope, without being soaked in any ley or prepared in any way whatever, its use is to keep a light so as to be prepared to fire at all times, it burns about one foot in an hour. The strands are generally sewed together to prevent their spreading out by the explosion of the piece when fired.

Sometimes the rope is soaked in saltpetre water, but it is not necessary.

WHAT size is slow match? Two inches in circumference.

INSTRUMENTS.

WHAT kind of Instruments are in common use?

The perpendicular, quadrant, tangent scale, calibre compasses, searcher, fuze augur, fuze engine, fuze pincers, driver and setter, and spikes.

These are the common instruments in general use and with which every Artillery man should be acquainted.

PERPENDICULAR.

WHAT is a perpendicular?

A common spirit level, the brass frame in which it is placed being the most convenient shape for applying it to the purpose required.

WHAT is the use of a perpendicular?

To draw a line on the exterior surface of a piece of Ordnance, to correspond with its axis.

WHAT is the use of this line, and what is it called?

This line is called the line of metal, and serves to lay the piece at the object against which its fire is directed, the Gun being traversed to the right or left till the line of metal and object to be struck, exactly come in line.

SUPPOSE the distance between the piece and object be such as to require elevation or depression, is this line still to coincide with the object?

Yes, in laying the piece, afterwards the requisite elevation or depression is given, otherwise the line of direction cannot be correctly taken, particularly when the object is small.

How is the instrument used, or the line

The instrument is placed on one of the mouldings, or any convenient

of metal taken with it?

part of the upper surface of the piece, the legs at right angles to the bore and moved to the right or left, till the bubble in the glass stands steady in the centre, the perpendicular (from which the name of the instrument is derived) or slide, whose point is previously chalked, is then gently pushed down till it touches the metal leaving a mark on it, called *a centre.*

The instrument is then removed and as many more *centres* taken in the same manner as may be required.

How are you sure the line of metal thus obtained corresponds with the axis of the piece?

Although the exterior of a piece of Ordnance differs in shape from the interior, still the parts are all circles emanating from the same centre, consequently provided the piece be properly turned, and the perpendicular correct, from the nature of the level, the bubble will not remain fixed, unless it is exactly over this common centre.

How do you ascertain the instrument is correct, and the piece properly turned?

It is easy to ascertain whether any defect exists, by taking three centres, stretching a chalked thread touching the two outer ones, raising it a little, and then letting it go, when a chalked line will be left along the surface of the piece, connecting these three points if they form one right line, otherwise there must be a defect somewhere, and all the centres should be taken again.

It is evident two centres would not be sufficient, as in whatever position they may be in, a thread as above described would connect them; should this line cross the axis of the piece, in however small an angle, the shot

will be carried farther from the object as the range increases.

This would not happen should the line of metal be parrallel to the axis of the piece, although not exactly over it. The shot would then proceed in the parallel direction to the object, and as these lines cannot be very far apart would be attended with the desired effect.

How many centres is it usual to take?

Two with Guns, and three with Mortars.

Why are more centres taken with Mortars than Guns?

With a Gun, the eye is lowered so as to look along the whole length of the piece, one centre at the eye on the base ring, and another at the swell of the muzzle, has been found sufficient to direct the eye to the third point, the object aimed at; chalking a line along the whole surface of a long Gun, would be a tedious operation, would occupy more time and attention than could be generally spared on service, where indeed with light Guns, centres are seldom or ever taken, as new ones would be required every time the Gun moved, or any alteration in the level on which it is standing.

Most field pieces have centres cut on their base rings, tangent scales, and muzzles, although these are liable to error, after a round or two the Men are enabled to make the necessary allowances.

Mortars are stationary and the eye does not here come in contact with the piece but is removed at some distance from it, the more centres that are taken, or the longer the line marked on

the surface of the piece to be covered by the plummet line held by the person laying the piece, the more chance there obviously must be of the shell going correct.

How do you adjust a perpendicular when out of order, or know when it is out of order?

The best way of ascertaining that perpendiculars are correct or otherwise, is occasionally to examine all in Store, and mark on a table or other surface as level as can be procured, the exact space occupied by a perpendicular, that is where the two legs touch, then tighten or loosen the adjusting screws at each end of the level, till the bubble is in the centre, place all the others exactly in the same place in rotation.

Seldom or ever a pattern level can be procured in this country that can be depended on.

QUADRANT.

What is a quadrant?

A graduated quarter of a circle, fixed to a long brass bar or rod, which goes into the bore of a piece.

What is the use of a quadrant?

To elevate or depress a piece of Ordnance.

How many kinds are there?

Two—spirit level and plummet.

What is a spirit level quadrant?

When the index denoting the angle, has a spirit level attached to it.

What is a plummet quadrant?

When the angle is shewn by a line with a plummet attached to it, is let fall from the centre of the quadrant and thus denotes the angle of elevation.

Which is considered the best?

Both are in common use, and equally applicable for service, the spirit level quadrant is in more general use for Mortars, and the plummet quadrant for Guns, under all circumstances probably the plummet quadrant can be made more accurately than the spirit level quadrant, being more simple in its construction.

For Guns which are seldom elevated above 5 or 6° smaller angles are sometimes used with a spirit level index.

How is a quadrant applied to a piece of Ordnance?

The long shank is placed in the bore on the lower surface, as near as possible in the centre, and kept steady with the hand, the longer the shank is, the steadier the instrument will be, it should not however touch the shot, or shell, in the piece.

How is the angle of elevation taken with the spirit level quadrant ?

The index to which the level is attached is fixed to the required angle on the graduated arc, previous to its being put into the mouth of the piece. The piece is then elevated till the bubble in the glass level is steady and visible, so the bubble remains without moving and the whole of it seen, it is considered sufficiently accurate, without its being exactly in the centre of the glass tube.

The index is then parallel to the horizon or spot on which the piece is standing, and the piece will form with these parallel lines, the angle at which the index is set.

How is the angle of elevation taken with the plummet quadrant ?

A musket ball or other weight attached to a thread, is suspended to a small hook or screw head, projecting from the centre of the graduated arc, which from the properties of gravity will hang perpendicular downward, the piece is then gradually elevated till the thread covers the required angle on the graduated arc.

The piece will then form the angle, denoted by the plummet line on the graduated arc, with the spot on which it is standing, or with the horizon.

How is a quadrant adjusted when out of order ?

A spirit level quadrant in the same manner as a perpendicular, by placing a number one after the other exactly on the same spot, on some level surface, and setting the index at 0, adjusting the level till the bubble stands in the centre of the glass.

The plummet quadrant can only get out of order by being bent, or the arc not properly graduated, which can

be discovered by inspection, or applying compasses to the divisions.

It appears with both these instruments, the angle of elevation given, shews the angle the piece forms with the spot on which the Gun is standing, suppose the object fired at, is higher or lower, than that spot; how do you give the required angle?

The quadrant will not give any angle but in reference to one level, in which consists its deficiency.

TANGENT SCALE.

WHAT is a tangent scale?

A cylindrical brass rod fixed into a groove cut for it behind the base ring of field ordnance. On the face of this rod, tables are engraved by which the length of fuze, angle of elevation, and length of range can be ascertained instantaneously.

WHAT is the use of a tangent scale?

To elevate pieces of ordnance.

How is a tangent scale made?

·21 of an inch is the tangent of one degree to every foot of a Gun's length, from the base ring to the swell of the muzzle; therefore if the distance in feet between these two points be multiplied by ·21, the product will be the tangent of one degree, from which the dispart being subtracted, will give the length of the tangent scale above the base ring, for one degree of elevation for that particular Gun; when the Gun has a dispart, it is not to be deducted.

Tangent of 1 Degree to the following Ordnance.

	Length.		Tangent.	Dispart.
	Feet.	Inches	Inches.	Inches.
12 Pounder Medium......	6	6	1.365	1.475
12 ,, Light.........	5	0	1.05	1.
6 ,, Heavy........	7	0	1.47	1.32
6 ,, Light........	5	0	1.05	1.08
3 ,, Heavy........	6	0	1.26	0
10 Inch Howitzer.........	3	$11\frac{1}{2}$	.84	0
8 ,, ,, ...	3	1	.64	0
$5\frac{1}{2}$,, Light........	2	$2\frac{3}{4}$	.47	0
$4\frac{2}{5}$,, ,, ...	1	10	.384	0

Tangent of 1 Degree to the following French Guns.

Nature of Ordnance.	Siege.						Field.					
	Tangent of 1degree			Dispart.			Tangent of 1degree			Dispart.		
	In	Li	P.	In	Li	P.	In	Li	P.	In	Li	P
24 Pounder..........	2	1	5	1	2	4	0	0	0	0	0	0
16 „	2	0	0	1	1	0	0	0	0	0	0	0
12 „	1	10	6	1	0	0	1	4	0	1	3	0
8 „	1	8	3	1	0	0	1	2	½	1	2	0
4 „	0	0	0	0	0	0	1	0	0	1	0	0
6 Inch Howitzer....	0	0	0	0	0	0	0	5	6	0	0	0

As the French tangent scales are marked off in inches and lines, the above dimensions are given in the same, for the more ready turning the French elevations into degrees, and thereby comparing their ranges with the English.

How is the tangent scale applied to use?

The distance of the object from the piece being known, loosen the adjusting screw, and raise the rod until the required distance engraved on it appears, then fasten the screw, get the top of the scale, the sight or centre on the swell of the muzzle, and the object to be fired at in a line, the piece will then be elevated at the angle corresponding with the distance and the object itself.

As the tangent scale is for the same purpose as the quadrant, what advantage has it over the latter instrument?

It gives the angle of elevation the Gun itself makes with the object fired at, without any reference whatever to the levels they may be on, in which consists its excellency. Another advantage the tangent scale has over the quadrant—safety and expedition, instead of going to the front of the piece and there applying the instru-

ment, the tangent scale from its position behind the breech is raised by the person laying the piece who also turns the handles of the elevating screw as required, and performs all these operations at once, and almost in the same time a person would be elevating a Gun alone with the quadrant.

Is the tangent scale considered as correct as the quadrant ?

No—the tangent scale and quadrant never give exactly the same angle, the latter instrument is considered the most correct but the former is sufficiently so for all common purposes.

WHAT are the different figures and letters on the tangent scale for ?

On the round side the first fraction shews the length of fuze composition in tenths of an inch ; in the second fraction $\frac{\text{From}}{\text{To}}$ the numerator, tells at what distance the shell will burst with that length of fuze, and the denominator the distance the small balls will fly afterwards.—For instance 4 G $\frac{7}{10}\big|\frac{1160}{1330}$ indicates that with 4° elevation $\frac{7}{10}$ of an inch of fuze composition the shell will fly 1160 yards before bursting, and the small balls liberated from the shell will continue their flight to 1330 yards. The letter on the scale, shews the box from which the fuzes are taken, they are generally in the Royal Artillery carried ready cut.

QUARTER SIGHTS.

WHAT do you call quarter sights?	A small notch cut at the sides of theGun, at the muzzle and base ring on both sides so as exactly to cut the bore in two parts horizontally.
WHAT is the use of quarter sights?	To lay the piece by.
How is the piece laid by quarter sights?	On each side the notches on the base ring, degrees are marked off—those *below* shewing the depression and those *above* the elevation of the piece. The line denoting the required elevation or depression must be in line with the notch at the side of the muzzle and the object aimed at—when the piece will have the desired elevation.
Is this mode considered correct?	No—very frequently the make of the carriage prevents the two lines or notches being seen.

No mode is so convenient for laying Guns as the tangent scale.

CALIBRE COMPASSES.

WHAT are calibre compasses?

The common pocket calibre compasses consists of two flat brass plates, six inches long, connected by a screw, and about $1\frac{1}{2}$ inch in breadth with a variety of tables engraved on them.

They can be made of any size, and any useful tables may be engraved on them; those actually required for using the instrument are marked "Inches," "Guns," "Shot," and the degrees round the semicircular end.

The points are tipped with steel, that they might not wear out.

OF what use are calibre compasses?

To measure the calibre of any piece of Ordnance in order to ascertain its nature, likewise the diameter of shot and shells for the same purpose; angles may also be taken with them.

The calibre compass is the most useful instrument an Artillery Officer can have, the most experienced eye cannot judge accurately of the nature of pieces of Ordnance, and shot, particularly when very small; mistakes might arise by shot of one calibre being sent with Guns of another. In reporting the nature of captured guns, this instrument is very useful.

How is the calibre of a Gun taken?

The legs of the instrument are made to cross each other and placed in the bore of the piece, till the two steel points touch the sides, turn it gently round to ascertain if it is properly bored, which it will be if the points touch the sides in the whole circum-

ference, withdraw the instrument and inspect the plate with "Guns" and "Inches" on it, the figure that is cut by the leg crossing it on "Guns" will denote the calibre of the piece relative to its shot. For instance, "figure 9 will denote a 9 pounder," the number on "Inches," the diameter of the bore in inches—which in this case will be 4·2 inches, each division being $\frac{2}{10}$ths— a straight line connecting the two steel points will be exactly 4·2 inches.

How is the calibre of a shot or shell taken?

Open out the legs and place the shot or shell between them, let the points touch the surface of the shot, move the Instrument up and down in your hands, to ascertain that you have taken the proper diameter, that is, of the largest part, in case it should not be quite spherical—inspect that part marked "Shot" at the semicircular end, see which division the index † cuts, the figure will shew the nature of the shot in lbs.; thus, the Index cutting 18 will shew that the shot is an 18 pounder and so on.

The figures in the lower row are intended for the divisions in the upper row that have none.

The figure under the part marked "Shot" shews the diameter in inches, an 18 pounder for instance 5 inches.

How do you take the angle of elevation with the calibre compasses?

Place a straight stick or any thing of that kind in the muzzle, allowing the end to project beyond it, to which fasten a plummet line, place the circular part of the compasses as near the junction of the stick and line as possible without moving either, let the

outer part of one leg in its whole length touch the under part of the stick, move the other leg till it in the same manner comes in contact with the plummet line—remove the instrument and observe what degree the chamfered edge cuts on the semicircle below, which will be equal to the complement of 90° of the true angle of elevation.

This method is not so correct or so easily effected as with the quadrant, or tangent scale.

How do you lay down an angle with a pair of calibre compasses—say of 30°?

Open the legs till the chamfered edge cuts 30° on the outside scale, draw two lines along the outer edges of the legs, till they meet in a point, which will form an angle of 30° or, crossing the legs make the chamfered edge cut 30° on the inner scale, and the opening between the legs will be the required angle.

CALIBRE COMPASSES

for taking the thickness of a Shell's bottom.

How do you take the thickness of a shell's bottom with this instrument?

Put the straight leg in the fuze hole, and let it press against the bottom of the shell, then shut up the compasses as far as you can, that is, till the check on the curved part near the handle stops it, by inspecting the instrument it will be evident the straight leg, and the index at the end of the curved leg, will be in a line, slide on the index till it touches the shell's bottom, which alone will prevent the two points meeting; the

figure on the scale cut by the index will give the thickness of the bottom, —in tenths of an inch; for instance, if 8, will be $\frac{8}{10}$ of an inch thick at that part.

CALIBRE COMPASSES

for taking the thickness of a Shell's side.

How is the thickness of the side of a shell taken with this instrument?

Put the straight leg with the end bent inwards into the fuze hole, and make it touch the side of the shell in any part, shut the compasses till its fellow circular leg, (both these legs are tipped with steel to prevent their wearing out), touches the outer surface of the shell, when it will be evident the side of the shell will be between the two points, to ascertain its thickness look at the scale *above*, of tenths of an inch, and observe the figure cut by the index, which will indicate the thickness of the shell in tenths of an inch,—for instance if the index cuts the figure 8 the side of the shell will be $\frac{8}{10}$ of an inch thick.

SEARCHER.

What is a searcher?

An instrument for examining the inside of a piece of Ordnance to ascertain the bore is free from cavities; if any, their size and position.

Describe the instrument and how it is used?

The instrument consists of a long wooden handle or pole, hollowed, through which passes a rod of iron,

with a ring at the end, this is called the *reliever*. Eight points fixed perpendicularly to as many iron prongs, are fastened to the end of this pole, the ring of the reliever, by being pushed on towards the points, closes them all within it, when they are put into the muzzle of the piece, to be examined; by drawing the handle back, the prongs being elastic, the points spread out and press against the sides of the bore, by moving it about in all directions, should there be any cavity one of the points will enter it.

The handle close to the muzzle is then marked with chalk, to shew the position of the cavity, the point disengaged by closing all the points with the reliever.

How do you find the shape and size of a cavity?

The points are kept closed, one is covered with bees-wax, and introduced into the piece, the chalk mark on the handle, shews the distance of the cavity from the muzzle and the position is known by the person who used the instrument, the point with the bees-wax is gently put into the cavity, and withdrawn in the same manner, when the wax will correspond in shape and size with that of the cavity.

How do you search the vents of Guns?

Pass a piece of whip cord about twice the length of the Gun, down the vent, and pull one end out of the muzzle with a searcher or other convenient instrument, put a piece of bees-wax round the middle of the string and pull it into the Gun by the end at the vent. The appearance of

the lower part of the vent will be left on the wax by using a moderate degree of force. Two small pieces of stick put cross-ways through the cord under the wax, will prevent the wax from slipping along the string, and the part should be slightly elongated that has to go into the vent, and oiled to prevent adhesion to the metal.

This mode of searching the vents of pieces of Ordnance, was suggested by Captain Montgomerie of the Madras Horse Artillery.

FUZE AUGERS.

What is the use of a fuze auger?

To bore the composition out of fuzes, when the required length is so short, that if cut across there would not be sufficient wood to hold in the fuze-hole as is generally the case with spherical case shot fuzes.

How is the auger used?

The fuze is cut square across at one inch from the upper circle or commencement of the composition. The scale attached to the index or slide of the auger denotes tenths of an inch. If for instance it is required to leave $\frac{3}{10}$ of composition in the fuze the index is moved till the lower edge of the slide is in line with the figure 3, the auger itself will then be $\frac{7}{10}$ above the brass guard.

The head of the fuze is placed against the side of the carriage or any thing that will keep it steady, small wooden vices screwed to the ammunition waggon are sometimes provided for the purpose, and the auger used in the common way.

What is the difference between a brace and hand auger, and which is the best?

The hand auger has merely the wooden handle screwed on the brass scale and is used like a gimblet. In the brace auger the same wooden handle fits the brace, to which the same scale is attached. The brace auger is the most convenient of the two, the handle rests against the breast, and the operation is performed with certainty and expedition. The handle when used as a gimlet is apt to hurt the hand, and the auger to slip, not being supported as with the brace, more time is required in boring a fuze with a hand auger.

DRIVER AND SETTER.

What is a setter and its use?

A setter is a cylindrical piece of wood, hollowed about an $\frac{1}{2}$ inch in depth, to receive the head of a fuze the diameter must depend on the size of the fuze for which it is required, the height about 3 inches and the handle which is a continuation of the same cylinder, smaller, and high enough to allow the hand to grasp it, on the top of this handle the driver is applied in setting the fuze.

What is a driver and its use?

A cylindrical piece of wood differing from a common mallet only in the handle and striking part being all one piece of wood, the handle sufficiently long and of the most convenient size for being held in the hand

How is a fuze set?

A little oakum is put up the hollow part of the setter, or the head of the fuze would be injured by coming in contact with the hard wood of the

setter. The fuze being placed by the hand as far into the fuze hole as can be done, the hollow part of the setter is placed on it, and the left hand on the handle, the driver is then applied to the top of the setter, held by the right hand, no force is required, or the head of the fuze would be split, the weight of the driver falling should be sufficient. After every blow the handle of the setter should be moved round without being lifted up, so that no two blows should fall on the same spot—this precaution is necessary to secure the fuze from injury.

FUZE ENGINE.

What is the use of a fuze engine?

To extract a fuze from a shell, more particularly applicable to large shells.

How is it used?

The circular part at the bottom rests on the shell with the head of the fuze in its centre. The two small notches in the under part are to receive the lugs on the shell, which keeps the instrument steady.

The screw is turned till the vice embraces as much of the head of the fuze as can be got at, and then fixed as tight as possible on it.

Turn the upper screw which will draw up the vice, and of course the fuze with it.

FUZE PINCERS.

For what purpose are fuze pincers required?

They are used to draw the fuze out of a shell when it is damaged in any way, it will only answer for small and short fuzes such as those for spherical case shot.

The pincers are opened and the hollow part put round the head of the fuze, they are then closed and turned round with the hand till the fuze is extracted.

Fuze pincers have generally two circular holes to answer for different sized fuzes, and are notched inside to take a better hold of the head of the fuze.

SPIKES.

How many different kinds of spikes are in common use, to render Guns temporarily unserviceable?

Three, — round, ragged, and spring.

What is a round spike, and how is it applied?

A round spike is nothing more or less than a steel nail without a head, of a conical shape, when it will fit any vent,—should there be any difference in their size.

It is driven into the vent with a hammer, and the projecting part broken off.

What is a ragged spike and how is it used?

A ragged spike differs from the round spike in being nearly square; and all its angles cut like a file but coarser and deeper, the points of the jags being upwards.

It is more difficult to extract than the round spike when driven into the vent of a Gun.

To clear a Gun of these two kinds of spikes, is the same method adopted, and what is it?

Yes, if a Gun is spiked with the common spike, load with rather more than a third of the shot's weight of powder; soak two wads in a solution of saltpetre, and when dry place a shot between the wads, which must not be made too high, bind them together with long strands of quick match, and ram the whole home on the charge, put an ounce or two of gunpowder in the copper ladle and scatter it along the whole length of the bore, then fix a wad, or turf in the muzzle of the piece, with half a port-

fire passed through it, by which means a Gun may be easily fired. If this does not cause the spike to remove, repeat the experiment with an additional shot or wad.—With brass Guns it would be advisable, a day or two previous to the experiment, to scratch close round the spike with a graver, and put a few drops of aquafortis in the circle, which in a few hours will find its way down between the spike and the metal, particularly if the former is not perfectly round.

WHAT is a spring spike and how applied?

The head is like that of a musket ramrod, the lower part resembles an arrow.

The point is driven into the vent which presses the two springs or arrow-head close to its sides, when they have passed through the metal into the bore, both open out, and the instrument cannot be drawn out from the outside until these springs are broken off.

Is there no means of extracting a spring spike?

Yes, by means of a reliever which consists of a flat circular piece of iron just large enough to go over the head of the spike and press the springs close to its sides, this is screwed or fastened to a long handle or rammer head which is put in at the muzzle and when it has caught the end of the spike pressed up to the head of the springs when the spike can easily be drawn up from the outside. These kinds of spikes are only used when it is expected the guns will be immediately retaken; as the spike can so easily be withdrawn, relievers are always carried with them for the pur-

pose, but must be carried away when the Gun is abandoned, or the enemy will take advantage of them.

But cannot these spikes be used so as to prevent their being thus easily taken out?

Yes,—having first spiked the Gun, ram home some clay or lime to the bottom of the bore, and after it a shot enveloped in felt, leather, or woollen cloth.

The French use a square steel spike, tempered, except at the point, which is made of sufficient length to pass through the whole of the vent, and project two or three inches within the bore: it is then rivetted inwardly, by being struck forcibly with the rammer head. Spikes are sometimes formed with a worm like a screw except towards the point, which is not tempered and is rivetted as before; this operation requires two hours and a quarter.

Table of the Dimensions of Spring Spikes.

Nature.			Spike's Length	Spring's Length
			Inches.	Inches
12 Pdr.	Heavy and Medium		$7\frac{1}{2}$	$2\frac{3}{4}$
	Light		7	2
9 Pounder			7	$2\frac{1}{2}$
6 Pdr.	Heavy		$6\frac{1}{2}$	$2\frac{1}{2}$
	Light		$5\frac{1}{2}$	$2\frac{1}{2}$
Howitzer	8 Inch		$7\frac{3}{4}$	$3\frac{3}{4}$
	$5\frac{1}{2}$	Heavy	$7\frac{1}{2}$	$2\frac{3}{4}$
		Light	$6\frac{1}{2}$	$2\frac{1}{2}$
	$4\frac{2}{5}$		$6\frac{3}{4}$	$2\frac{1}{2}$

BATTERIES.

What is a battery? Any number of pieces of Ordnance, placed in a row near each other, covered from the fire of the enemy, by a bank of earth, thrown up in front of them for the purpose, or, placed behind any obstacle that may shelter them, and at the same time admit of their firing on the required point; when Guns are drawn up without any cover, as field pieces usually are in battle, it is called an open battery.

What are the principal dimensions of a regular battery? The height of the battery should be sufficient to cover the Men and Guns behind it, 7 feet; the thickness sufficient to prevent the enemy's shot passing thro' it, it must be recollected that a shot will penetrate farther into earth newly thrown up, than when well settled--from 18 to 20 feet thick; the Guns should be sufficiently far apart, that they may be worked without inconvenience, 18 feet; the slopes of the battery should be sufficient to keep the earth from falling down, as it would be inconvenient to make the interior slope so great it is usual to strengthen it with fascines, otherwise the Guns would be at too great a distance from the parapet and the explosion would very soon destroy the embrazures; the principal use of the ditch is to supply earth for the parapet, and may be made of any depth or breadth, it also serves as a defence; the berm is necessary to prevent the earth sliding into the ditch, which it would if the exterior slope and escarpe formed

one slope, the smaller the embrazures are, the better, so that as little as possible should be exposed to the enemy's fire, the genouillere should cover completely the lower part of the carriage, allowing the Guns to be depressed as much as may be required.

The usual dimensions of Gun and Mortar batteries are as follows.

	ft.	in.
Thickness of parapet....	18	0
Interior slope...........	1	$10\frac{1}{2}$
Superior do.............	1	2
Exterior do.............	6	4
Berm....	3	0
Escarpe slope...........	5	0
Breadth of ditch........	10	0
Counterscarpe slope......	5	5

Embrazures.

	ft.	in.
Interior opening..	2	0
Exterior opening....	9	0
Height.......	4	0
Slope outwards....	1	6
Genouillere height..	3	0

IN what do Mortar batteries differ from Gun batteries?

In having no embrazures and the superior slope inwards instead of outwards; of late this slope has been made the same in both Gun and Mortar batteries.

WHY have Mortar batteries no embrazures?

Because the high elevations at which they are fired, throws the shell clear of the parapet.

How far are Mortars usually placed from the parapet, and how far from each other?

Usually 15 feet from each other, and at the following distances from the foot of the interior slope of the epaulment according to the angles at which they are to be fired.

At 10 feet,	for	firing	at	45	Degrees.
12	,,	,,	,,	35	,,
14	,,	,,	,,	30	,,
17	,,	,,	,,	25	,,
19	,,	,,	,,	20	,,
30	,,	,,	,,	15	,,
56	,,	,,	,,	10	,,
80	,,	,,	,,	5	,,

How far are Guns usually placed from each other?

18 feet; the distance should be such that the Guns can be freely worked without incommoding each other, and that the shock in firing may not affect each other, which it is very apt to do, causing the elevating screws to run down, and altering the direction, by the vibration of the piece on its platform; the distance should also admit of traverses being thrown up between the Guns as well as on the flanks, which is necessary when the enemy can enfilade the battery.

WHAT do you understand by enfilading a battery?

When the enemy bring their guns to bear on either flank of the battery, so as to rake the whole line, or, when their Guns are drawn up in a line perpendicular to the Guns in the battery.

WHAT is the best and most advantageous height for placing a Sea battery?

Most military writers prefer low situations for Sea batteries, but Monsieur Gribauvale lays down some rules for the construction of these kind of batteries in which he says that from a height of about 14 yards and 200 of distance, a battery may ricochet a vessel in perfect security, for their riochet being only from a height of 4 or 5 yards, it can have no effect against it.

WHAT force ought a battery of 4 or 5 Guns to be capable of resisting?

It has been estimated that a battery of 4 or 5 Guns, well posted ought to be a match for a first rate Man of War.

In what situation should temporary magazines for batteries be constructed?

Temporary magazines should be constructed about 6 or 7 fathoms in the rear of the battery, and they should always be placed in rear of one of the merlons, in order to screen them from the fire of the enemy.

Of what dimensions are temporary magazines usually constructed?

They are usually made about 8 or 9 feet square, and they will hold about 1 or 2 tons of powder; two of these small magazines will be required for a battery of six guns.

Why should the powder be distributed in two or three of these small magazines, instead of being all contained in one?

Small magazines are preferred to large ones as it is better to lose a small quantity of powder from time to time, than run the risk of the whole being destroyed by a single shell falling into the magazine.

In what manner are Howitzer batteries constructed?

Howitzer batteries are constructed the same as Gun batteries, except that the interior openings of the embrazures are 2 feet 6 inches, and their soles have a slope inwards of 10 deg.

What are plein fouet, or direct batteries?

Batteries placed parallel to the object against which their fire is required.

What are ricochet batteries?

They are of the same construction as battering batteries, their use is to enfilade the faces of the works of the fortification, either with Guns, or with Howitzers; they are also called enfilading batteries.

What are barbette batteries?

Batteries whose platforms are elevated within 2 feet 8 inches of the crest of the parapet, the Guns firing over them.

What is a counter battery?

It is that which is raised to play on another battery, in order to dismount the Guns by a direct fire.

WHAT is a battery en echarpe?

It is that which plays obliquely upon the object against which its fire is directed.

How is a battery placed so as to enfilade a work?

From a point given in the prolongation of the face of a work proposed to be enfiladed, a perpendicular is erected, upon which the battery is constructed, at the distance of 24 feet from the produced line, in order to clear the thickness of the parapet.

WHAT is a sunken battery?

When the earth is dug from the interior to form the parapet instead of a ditch in front, part, or all of the parapet may be made in this manner.

WHAT is called a raised battery?

When it is necessary to construct a a mound on which the battery is to be made.

PLATFORMS.

How many kinds of Mortar platforms are there?

Two, fixed and traversing.

WHAT constitutes a fixed Mortar platform?

Fixed platforms for Mortars consist of three sleepers of about 10 feet in length, and 8 inches square, these are placed perpendicular to the battery, and buried level with the earth and quite flat, which is ascertained by a mason's level, and then covered completely with stout planks, 3 inches thick; on this the Mortar on its bed is placed, the whole platform weighs about 1186 lb. and can be conveyed on a bullock bandy or cart.

WHAT constitutes a traversing Mortar platform?

It consists of three sleepers placed parallel to the battery, with a frame of two sides connected by two cross bars, the front one fastened to the front sleeper by an iron pintle passing through both, on this pintle the frame traverses as likewise the Mortar, which is placed with its bed on it.

WHAT platform is considered the best for Mortars, the fixed or traversing?

The traversing platform; it is laid in much less time than the fixed platform, occupies less space in travelling, is lighter, and the Mortar is run up with little or no trouble, whereas in the fixed platform, the operation of running up the Mortar after firing, is very laborious and the planks are injured by the use of the crow bar which is indispensible with very heavy Mortars.

The traversing platform has only lately been introduced at Madras,

suggested by Captain Miller of the Bombay Artillery.

How many Gun platforms are there ?

Two ; traversing and dove tailed.

DESCRIBE a traversing platform for Guns ?

The traversing platform consists of three sleepers, two wheel planks, one centre or recoiling plank, one hurter, and one cross plank ; the three sleepers are placed parallel to the battery, the front sleeper laid close to the parapet, and buried so as to allow a slope of an inch in every yard of the platform's length which is usually about 18 feet at which distance the rear sleeper is placed, the centre sleeper whose upper surface should be rounded to enable the wheel planks to traverse freely on it, must be placed just in front of the hind part of the wheel planks, to prevent their touching the ground, and at the same time not so close as to prevent the platform traversing ; the two wheel planks are bolted to the front sleeper, their distance apart must depend on the breadth of the carriage to be placed on them. On these planks the wheels recoil, and in running up the piece, they are supported in the rear by the centre sleeper, and connected by a cross plank, to keep them steady and at the proper distance apart.

The centre plank extends from the front sleeper to the rear sleeper, resting on all three sleepers, bolted to the front one, also to the cross bar of the wheel planks, from which to the rear sleeper a groove is cut, in this groove slides a pintle fastened to the trail of

the carriage, which confines it in the recoil, and prevents the possibility of its running off the platform. On the top of the rear sleeper are a number of little holes to receive two iron pins, one is placed on each side of the centre plank, to prevent its moving when the direction is once taken.

Behind this sleeper a number of iron bolts project, by applying handspikes between any two as required, the whole platform with the Gun on it, is traversed. The centre or recoiling plank from its length is awkward to carry, and unless great nicety is observed in laying the platform it will not traverse freely.

It is evident the connecting bar of the wheel planks must be clear off the ground, or the free traversing of the platform will be impeded. The hurter placed above the front sleeper on the wheel planks, serves to keep them steady, also to prevent the wheels of the carriage in running up from injuring the battery.

The platform takes to pieces and can be conveyed in a bullock cart; the weight 1326lb. 12ozs. 8drs.

Describe a dove tailed Gun platform?

The dove tailed platform differs from the foregoing platform in being more solid, and not traversing; it consists of three sleepers placed in a similar manner to those in the foregoing platform, instead of a separate hurter the front sleeper is cut so as to rereceive the wheel planks, and projecting sufficiently above them to prevent the wheels running against the

battery, four wheel planks two on each side, four planks for the trail of the carriage wider behind than in front from which the name of the platform is taken.

The wheel planks are secured to the front and centre sleeper by strong iron flat headed bolts which pass through both, and secured on the top by screw nuts, the trail or dove tail of the platform, is in like manner secured to the centre and rear sleepers; this platform also goes on a cart; total weight 1340lb.

Which platform is considered the best?

At Madras, the Artillery Select Committee have given it in favor of the dove tailed platform, because it is the steadiest, more simple in its construction, very portable and easily laid, and recommended its general adoption into the Service. The flat headed bolts are much superior to the long ones formerly used, being not only 66 lbs. lighter, but much time is saved in laying the platform, and in driving the long ones the planks are liable to split. A 24 pounder was placed on this platform during a Practice which shews it is sufficiently strong for any piece of Ordnance in common use. Earth should be rammed under the planks, and the sleepers secured with pickets.

What is the slope given to Gun platforms, and why any slope?

One inch to each yard of the platform's length, *inwards* towards the parapet; the slope is useful in two ways, to prevent the Gun running so far back in the recoil as it otherwise would do, and to facilitate the running up the Gun when loaded.

As the hind part of the platform is raised, how are the wheels of a Gun carriage mounted on it?

Common quoins or inclined planes, are placed close to the ends of the wheel planks, up these the wheels are run, the trail can be easily lifted up.

When platforms cannot be procured is there any way of preventing the Gun from recoiling inconveniently?

Place a quoin or inclined plane, the same as above described, behind each wheel nearly touching the lower fellie, in its thinnest end, the Gun will not run the whole way up it.

Are regular platforms absolutely necessary?

No, so the wheels and the trail are prevented from sinking, it is quite sufficient; two or three common planks will generally answer this purpose.

PRACTICE.

WHAT do you understand by Artillery practice?

The firing of Guns, Howitzers, and Mortars at particular objects, regulating the charges of powder, elevation, &c. so as to hit the mark.

HEAVY GUNS IN BATTERY.

THE Guns being in battery, and every thing prepared, what are the general rules for opening the fire?

1, Take the centres at the muzzle and breech.

2, Load, powder, wad, shot, wad.

3, Lay the Gun.

4, Elevate.

5, Fire.

SHOULD Guns in breaching batteries be fired singly or in salvos?

After a breach is properly marked out, the Guns should fire together by word of command, the shock of several shot striking the wall being proportionably much greater than the individual effect of the same number.

AT what should the fire first be directed?

At the lowest part of the object to be breached, its fall will bring down the upper part bodily; if the top is first knocked down the rubbish would cover the bottom and prevent its being breached.

How many rounds are fired a day from a Battering Gun?

That must depend on circumstances, the guns must not be overheated; the sooner the breach is rendered practicable the better, or an enemy may throw up an intrenchment behind it, and be more forward in their preparations to receive the storming party. From 200 to 300 rounds a day

can be fired from each piece and even more, but screw vents should be at hand; after every two hours or so, the fire should cease for a little while the Guns laid under metal, and well washed out.

Is it usual to fire during the night?

No; if the breach can clearly be seen, and dispatch necessary, there is no reason why the fire should not continue during the night, but the Men should not be uselessly harassed. It is usual when the breach is pretty far advanced to fire a round of grape every quarter of an hour into it to prevent the enemy from repairing it.

Where is the ammunition kept, required for the use of the Battery?

A small magazine is made in the most secure place that can be found near the Battery, either in its rear or on one flank; never more than enough ammunition for one day's supply should be kept in these magazines; they should be refilled during the night.

FIELD GUNS AND HOWITZERS.

WHAT precautions and preparations are necessary in opening the fire of a Field Battery?

Confusion and hurry to be avoided as much as possible, every one to be at his proper post, and know what he has to do; the limbers to be well out of the way, and at the same time prepared for limbering up at the shortest notice, when a change of position is required. The man serving the vent to be very steady and perform that duty properly, or the spunger will be blown away. The wooden bottom to be *next the powder*; in firing cannister shot the iron bottom to be put *inwards next* the *powder*, or its effect will be lost, powder and shot to be well rammed home and the cartridge pricked previous to priming. All these points should be particularly attended to by Officers, and Non-Commissioned Officers.

SHOULD Field Pieces be distributed along the line or in large batteries?

In batteries of 8 Guns at least; these batteries not farther from each other than their shot will form a cross fire, and protect the troops between them.

Two or three Guns fired at an enemy's line at intervals, would make but little impression, and would not be observed, but 16 Guns bearing on the same point would form a sensible breach at that part of the line where their shot united, and would not only tend to cause confusion, but would make an opening for the charges of Cavalry or Infantry.

How should Artillery be placed with regard to the Infantry?

Never when it can be avoided unless great advantages offer themselves, should the Guns be immediately in front or rear of the line, as a double mark

would then be offered to an Enemy.—Guns in small lines are usually on the flanks, when the line is so long that these two batteries cannot cover it by their fire, a third battery is posted in the centre, and as many more as may be necessary, intervals between Regiments, being left for them.

At what distance should the different kinds of shot be fired?

No shot can be depended on beyond 1000 yards; but they will range much further, in firing at a large column or mass at that distance, execution may be done, round and spherical case shot, should not be fired at a greater distance than 1000 yards; cannister within range is preferable to round shot or spherical case shot.—For cannister shot 500 or 600 yards is the greatest distance at which it can be used with proper effect. When the Enemy comes very close a couple of cannisters may be put into the piece.

When it is absolutely necessary you should abandon your Guns, what steps are to be taken to render them of the least service to the Enemy?

If the Guns are likely to be retaken, drive a spring spike into the vent, a proportion of them with relievers and common spikes are carried with all Guns, a common spike cannot be withdrawn so easily, and should therefore not be used on these occasions; —the limber should be carried away, also the spunge, ammunition, and every thing likely to prevent the Enemy from using the Gun; the Gun may also be dismounted and thrown on the ground or a wheel of the carriage taken off.

Are the same general rules applicable to Howitzers?

Yes.

MORTAR PRACTICE.

How are Mortars placed in battery?

In line, behind and parallel to the epaulement?

As Mortar batteries have no embrasures, how is the object to be fired at, seen?

The object is not seen from the battery; two ramrods or pickets are placed on the parapet in line with the object, by these the Mortars are laid.

The Mortars being in battery, what steps are next taken?

The Mortars are scaled, the centres taken with the perpendicular, the elevation given, the quick match for priming put into the vent, the powder is set well up in the chamber, as even as possible with the hand, the shell is next lifted into the piece, the fuze hole in the centre, the elevation rectified if necessary, which is liable to happen from the shock of the shell striking against the muzzle, the fuze is uncapped and well dredged, the piece laid at the object and fired.

How are the shells lifted into a Mortar?

For very heavy shells such as 13 inch, a crane is fixed to the bed, or in the platform, for the purpose of raising them up to the muzzle of the piece, 10 inch shells are lifted by means of two hooks, called *cant hooks* connected by a short rope: these hooks are put through the lugs on the shell, care being taken that they are turned different ways, or they may fall out and let the shell down: two men lift the shell to the muzzle, by means of a hands pike over which the connecting rope of the cant hooks pass when one gradually lowers it in, and withdraws the hooks:--all smaller shells are put in with *bearing leathers*, that is two stripes of sheep skin crossing each other, and sewn together, on which the

bottom of the shell is placed, then brought up above the fuze, the four ends are then taken in a man's hand, and the shell lifted into the piece, the leather, cutting off as much of the ends as can be come at, is fired away, the ends put clear of the fuze; the bottom of all shells should be wiped with oakum before they are placed in the Mortar, in case any particles of gravel or any thing else should adhere to them, and cause an explosion, on coming in contact with the bore; the shell should also, as a further precaution, be lowered in as gently as possible.

WHY is the powder well set up in the chamber with the hand?

To bring it as much as possible to bear equally on the shell; if the powder be strewed along the chamber so much would not be fired at the same instant, as when set up well together, and moreover, its effect on the shell would be unequal, more acting on one part than on another.

WHY are Mortars primed with quick match instead of powder as Guns?

Great nicety is necessary to regulate the charge to the required distance, a handful of powder, used as priming would materially affect this object which is the cause of quick match being used.

WHY are cartridges not used with Mortars?

Mortars are usually fixed at one elevation, consequently the charge must vary according to the distance; it is the reverse with Guns, the charge remains the same and the elevation varies with the distance.

This should not however by any means be considered a general rule to fire Mortars at a fixed elevation; in many cases it would be found adviseable

to fire at low angles, which must be left to the judgement of the Artillery Officer.—As the case now stands the charge varying, cartridges could not conveniently be made for every distance, it has therefore not been customary to use them at all, but to weigh out the powder as required; experience has however shewn that putting the powder in bags in no manner affects the ranges, it would therefore be advisable, whenever the distance is ascertained, by throwng a shell or two, to make up a proportion of cartridges to avoid both the trouble and danger of running backwards and forwards in a battery with loose powder.

Why are Mortars generally fired at 45°?

Because at that angle it was supposed the shell would range the farthest, which is not exactly the case, but near it. It is not always necessary to give a shell the greatest range.

In firing at troops behind a stockade, or under any cover, low angles are preferable so the splinters of the shell can reach them, if the shell ranges high in the air, the enemy will see it, and be enabled to get out of the way.

Where force is required, the greater the angle of elevation to a certain extent the better. All falling bodies are constantly increasing their velocity from the effects of gravity, until the resistance of the air, (which also increases as the velocity of the falling body increases, but not in the same proportion) counterbalances it, the body then descends with one uniform motion.

It is therefore useless to throw a shell higher, than for it to attain its greatest power in descending.

If this object only is attained in throwing a shell on a level plain, it is evident the same elevation would not give the full power to a shell thrown from a plain to a high hill Fort.

RICOCHET FIRING.

What is meant by ricochet firing?

When shot or shells are thrown with small charges, and elevated as high as 10 or 13° so that the projectile may make several bounds previous to reaching their object.

What is the object of ricochet firing?

In firing at works to enfilade the face or flanks by just clearing the wall and bounding along the rampart destroying men and gun carriages.

In these situations this object could not be attained by common firing, particularly if the works are higher than the battery, the shot would graze the parapet and pass over the men and guns.

In firing at troops the appearance of shells lobbing towards them with burning fuzes, are more apt to cause confusion particularly among cavalry, although it may not kill so many men as a shot which is not seen, besides a shot or shell fired with the full charge may pass over a whole column and not strike a single man, while one ricochetted would probably make several bounds among the troops before its force would be expended.

WHAT charge of powder and how much elevation is usually given to Ordnance in ricochet firing?

Each of these must depend upon the distance and difference of level of the object to be fired at, and particularly the spot where it is intended the shot shall make its first bound.

ARE high or low angles best calculated for ricochet firing?

Low angles are best, the smaller the angle is, under which a shot is made to ricochet, the longer it will preserve its force and have effect, as it will sink so much less into the ground on which it bounds.

WHAT angle of elevation is best suited to ricochet a fortification of any kind?

It should be sufficient to throw the shot just over the parapet.

IF the work to be ricochetted, should be of an extraordinary height, what must be done?

In this case the piece must be removed to such a situation and have such a charge that it can attain its object at 10° of elevation or not greater than of 13° or 14°, otherwise the shot will not ricochet and the gun carriage will suffer very much.

How should the guns of a ricochet battery be placed?

The first Gun so as to sweep the whole length of the rampart of the enemy's work at 3 or 4 feet from the parapet, and the rest of the Guns should take it at as small an angle as possible.

WHAT elevation is usually given to field Ordnance in ricochet firing?

The object fired at being usually infantry and cavalry, the Guns should seldom be elevated above 3° as with greater angles the balls would be apt to bound too high and defeat the object intended.

How is the elevation of a Gun to be encreased when the breech is on the transom?

By digging a hole and letting the trail down into it.

Why is it necessary to elevate Guns?

Because the shot only proceeds a very short distance in a straight line, it is then acted on by gravity and gradually descends to the earth: a shot cannot rise above the direction in which it is fired, except from the accidental circumstance of its striking against the lower part of the muzzle in quitting the piece when it will be tilted upwards.

It is therefore necessary to elevate the piece to ensure the shot striking any object at a distance from it.

MINES.

WHAT is a mine and its use?	An excavation made under ground, or, in a wall, or, in any body, to receive a charge of gunpowder to destroy it, by blowing it up.
	Mines are generally made under a building to blow it up, but sometimes in the buttresses of a bridge or wall.
WHAT is called a globe of compression?	It means the extent in diameter in which a mine acts, that is, the powder on ignition acts in every way alike, and must find a vent somewhere, which of course must be at the part which offers the least resistance.
	The greatest extent of an opening in the earth caused by a mine is six times in breadth or diameter the distance of the powder to the place from whence it forces an exit.
How do you find the charge to produce any desired diameter of excavation?	Globes are to each other as the cubes of their radii. Their radii are the hypothenuses of right angled triangles, of which the line of least resistance and the semi-diameter of the excavation, are the other two sides.
	The following will be the rule, the radius being found as above.
	As the cube of the radius of the globe of compression in the following table, (having the same line of least resistance as the required globe) is to the cube of the radius of the required globe; so is the charge corresponding in the following table; to the charge required.

Line of least resistance.	Charge for the Mine.	Line of least resistance.	Charge for the Mine.
Feet.	lb. oz.	Feet.	lb. oz.
1	0— 2	21	868— 3
2	0—12	22	998— 4
3	2— 8	23	1140—10
4	6— 0	24	1296— 0
5	11—11	25	1558— 9
6	20— 4	26	1647—12
7	32— 2	27	1815— 4
8	48— 0	28	2058— 0
9	68— 5	29	2286— 7
10	93—12	30	2530— 4
11	124—12	31	2792— 4
12	162— 0	32	3072— 0
13	205—15	33	3369— 1
14	257— 4	34	3680—12
15	316— 4	35	4019— 8
16	384— 0	36	4374— 0
17	460— 9	37	4748—11
18	546—12	38	5144— 4
19	643— 0	39	5561— 2
20	750— 0	40	6000— 0

This table is calculated upon a supposition that the excavation of the mine is a paraboboid having a base double the line of least resistance: and that 10lb. 10oz. of powder is sufficient for raising one cubic fathom of earth. By the rule above given may be found the charge for any mine, that shall only shake the ground, without making any excavation, by making the line of least resistance of the required globe, only equal to the radius of the globe of compression.

The charges thus found by means of this table, being only for one nature of soil, viz. light earth and sand (that for which the table is calculated) must be augmented according to the following table of Vauban; by one, four, five, seven, or nine elevenths of the charge found.

WHAT quantity of gunpowder is required to raise a cubic fathom of soil?

1—Light earth mixed with sand	11 lb.
2—Common earth............	12 „
3—Strong sand...............	15 „
4—Clay or fat earth..........	16 „
5—Old and good masonry....	18 „
6—Rock.....................	20 „

The following rule is, however, laid down by Belidor, and generally adopted; if it be intended that the mine shall produce its maximum or greatest effect—multiply the line of least resistance, expressed in feet by 300, the product will be the charge in pounds. Vauban.

WHAT is the best shape for the chamber of a mine?

The best form for the chamber would be spherical but from the difficulty of its construction, it is always made a cube of one inch larger dimensions than the box to contain the powder.

WHERE should the chamber of a mine be?

The chamber must not be made in the prolongation of the branch of the mine, but at one side, and lower than the level of the branch, if the soil be dry, but higher if it be wet.

How is the branch stopped up previous to the springing of a mine?

The branch of the mine to be sprung must be closed in the strongest manner by doors well secured by props, and must be stopped with earth or rubbish to a distance, taken in a

straight line, equal to one and half times the line of least resistance.

How should a mine be made to destroy a stone bridge?

A mine for the destruction of a stone bridge may be made in the following manner. Sink a trench in the form of a cross down to the top of the arch stones, the branches of the cross 10 feet long, put 160lbs. of gunpowder into each trench, for a thickness of arch of 3 feet, cover the powder over with strong planks and load them well with rubbish, or ram the earth well above, and fire it either with a hose or portfire secured with clay, a single trench cut across the crown of the arch 18 inches deep and loaded with 350lbs. of powder, will answer equally well, 220lbs. of powder in a strong case suspended under a wooden bridge, will be sufficient to destroy it. A stone bridge, if time will allow may be more effectually destroyed by mining the piers, as the destruction of one pier, causes two arches to fall.

At what distance can miners be heard when at work?

In the most easy ground to work, a miner may be heard to the distance of 14 or 15 fathoms under ground, and the noise made by fixing the frames of the galleries may often be heard as far as 20 or 25 fathoms, a drum braced, standing on the ground, with a few peas, or other round substances on the head, will be very sensibly affected by an approaching miner.

What sort of excavation is produced by the blowing up of a mine?

The excavation formed by the blowing up of a mine, is found by experience to be nearly a paraboloid.

WINDAGE.

What is termed Windage?

The difference between the diameter of the bore of a piece of Ordnance, and its Shot or Shell.

It is absolutely necessary to have Windage?

Yes, it would be next to impossible to make the bore and projectile exactly correspond, even if it did, the foulness of the piece from firing would soon prevent the latter being put home—besides red hot Shot, could not be fired as heat expands Shot.

What is the usual proportion of Windage?

In Guns and Howitzers $\frac{1}{20}$ the calibre of the piece. Mortars .15 of an inch. In Carronades the Windage is considerably less.

Is it a great disadvantage for guns to have much Windage?

Yes, as the fluid flies faster than the Shot, the more space there is between the Shot and bore, the more of it will thus escape, and not act on the projectile, it is calculated that nearly $\frac{1}{3}$ of the whole charge is lost by this means, the Windage has of late been reduced, and the charges should be also.

An excess of Windage in any piece of Ordnance tends to render it unserviceable, because the shot strikes against the interior of the bore, which blows, as the gun becomes hot, take greater effect, and frequently cause dents before any bulge or exterior imperfection is to be perceived; the shot is in consequence deflected from the true line of fire, and the elastic fluid which propels the shot escapes more freely, having a greater vent, consequently its effects are not so violent on the shot itself, and its

range is thus diminished; this diminution of range may also in some measure, be attributed to the axis of the shot lying below the axis of the bore, and thus the force of the elastic fluid does not act direct on the centre of the shot, more or less so according to the degree of Windage. The deflection of the shot is of much more consequence than the diminution of the range, as all guns carry their shot as far as any true aim can be taken with them.

Windage of Guns and Carronades.

Natures....	68	42	3	24	18	12	9	6	4	3	2	1
Guns......	..	.32	.30	27	.25	.22	.20	.17	.15	.14	.12	.09
Carronades.	.15	15	15	.14	.12	.12	..	..	..	..	..	..

Windage of Mortars and Howitzers.

From the 13 to the $5\frac{1}{2}$ inch the windage is ·15 of an inch, and that of the $4\frac{2}{5}$ is 2 of an inch.

Windage of French Guns.

Field Guns.—All one line of windage; about one fiftieth in an 8 pounder.

Siege Guns.—All $1\frac{1}{2}$ line; about one forty-eighth in a 24 pounder.

Mortars.——12 inch;—4 lines of windage.
10 inch;—1 line 6 points do.
8 inch;—1 line....... do.
Howitzers.—All———2 lines...... do.

ELEVATION.

What is the meaning of the term elevation as applied to a piece of Ordnance?

The elevation of a piece of Ordnance is the angle formed by the axis of the bore, and the ground on which the piece stands. If a gun be situated on a plane inclined to the horizon at an angle of three degrees, and the angle which the axis of its bore makes with the horizon be four degrees, the elevation of the gun will be only one degree, hence, in ascending planes, the elevation of the gun is equal to the difference of the elevations of the plane and gun above the horizon; and, in descending, it is equal to the difference of the depressions of the plane and gun below the horizon.

VELOCITY.

What is the initial velocity of a projectile?

The rate at which it flies the first second, when fired from a piece of Ordnance.

Is the charge of powder known that will give the greatest velocity to its projectile?

When $\frac{3}{8}$ of the length of the bore is filled with powder, the greatest possible velocity will be given to a projectile so says Dr. Hutton.

Is any advantage gained in point of velocity by encreas- the common service charge of powder?

No, and it has been found that the velocity given by large charges are very soon reduced to those given by moderate ones, for example, those given by one-half the shots' weight are reduced to an equality with those by one-third, after passing through a space of only 200 feet.

What is the greatest velocity that can be given to a projectile, and at what rate does the powder pass out of the piece?	According to Dr. Hutton the greatest velocity that can be given to a projectile is 3181 feet in a second. Robins says the powder passes out of the bore, when unobstructed, at the rate of 7000 feet per second.
What is the usual velocity given to shot?	Not more than 1200 or 1400 feet in a second, except at very short distances when great effect is required.
Why?	Because the air is not able to follow and assist the shot passing through it, at a greater rate than from 1200 to 1400 feet per second, consequently the shot has to resist the whole force of the air in its front without any support from behind which soon reduces it to that rate.
Does ramming home the powder with different degrees of force cause any effect on the velocity?	It does not appear to have any.
Do wads effect the velocity?	No.
Has the weight of the piece any effect on the velocity of its projectile, or, does it signify of what metal it is composed?	So as the metal is sufficiently strong to resist the charge, the weight or kind of metal is of no consequence in its effect on the velocity of the projectile, but for practical purposes, if a gun is very light, it will fly about more than a heavier one at the explosion, and renders its practice more uncertain.
How long does the charge act on the projectile after it has left the piece?	The moment the powder quits the piece it expands in every direction and no longer acts on the projectile except that portion immediately behind it.

Is the velocity affected by placing the projectile in immediate contact with the powder, or, at a distance from it?

In the former case the powder acts on it by pressure, in the latter it may be said to give the projectile a violent blow, which frequently causes the piece to burst, and is very dangerous, except in Mortars where the sides are capable of resisting this shock. According to Dr. Hutton, the velocity is greater when the Shot is in contact with the powder. A Shell from a Mortar will range much farther when the empty part of the chamber is filled with turf or Oakum, than when left empty.

Has the density of the air any effect on the velocity of projectiles?

No, according to Robins who fired several hundred Shot in very different seasons, and found no certain difference between the velocity of that fired at noon in the hottest sun, in the morning or evening, or, in the night, and in winter.

RECOIL.

What is meant by the recoil of a piece of Ordnance?

The running back of the Carriage after the piece is fired.

What causes the recoil?

As powder acts in every way, the portion of it that acts towards the breech of the piece forces it back.

Has the recoil any effect on the flight of the projectile?

No, it has been ascertained experimentally that the shot is out of the gun before it has recoiled $\frac{1}{4}$ an inch.

What ill effects has the recoil on the carriage?

Comparatively none, provided there is plenty of room for it so as not to come in contact with any body that may cause a sudden shock. A great recoil is so far inconvenient, in the trouble of running the piece up after each fire. The carriage would suffer more without recoiling from the shock the breech sustains on the explosion of the charge.

How far does a piece usually recoil?

This depends on circumstances, the greater the charge, the greater will be the recoil. A gun loaded with two shot will recoil farther than a gun loaded with one shot, because the two shot will cause more resistance, and enable a greater portion of the powder to ignite than a single shot, before they leave the piece.

The recoil also depends on the ground on which the gun is placed, under general circumstances, perhaps 8 or 10 feet would be the utmost a field piece would recoil, without a platform, from 4 to 8 feet may be taken as the average.

Heavy guns have their platforms 18 feet long with a slop of 9 inches,

the length of the wheel planks is $8\frac{1}{2}$ feet. The distance from the spoke on which the carriage stands to the head of the platform is 2 feet, consequently the remaining part of the wheel plank ($6\frac{1}{2}$ feet) is allowed for the recoil.

WHY do guns recoil more in damp than in clear weather on platforms?

Because the moisture on the planks assists the piece in sliding and running back.

CANNOT the shock carriages receive when Ordnance are fired at high elevations be remedied?

Yes, by taking off the wheels, thus lessening the angle formed by the trail and the wheels, as is frequently done with Howitzers.

DO Mortars recoil as much as guns?

No, they are usually fired at high elevations, the shock acting downwards, instead of horizontally does not force it back.

PENDULUM.

FOR what purpose is a Pendulum required in Artillery Practice?	To take the time of flight of a shell, that the fuze may be cut to burst it at any particular required point.
OF what does it consist?	A weight say a musket Ball attached to a silken thread, fastened to a stand so that it may vibrate freely.
WHAT length should a Pendulum be to vibrate seconds?	This depends on the latitude of the place at Madras about 39·03 inches.
How do you measure the length of a Pendulum?	From the centre of the Ball or weight, to the end of the loop, by which it is slung to the stand.
WHAT length of Pendulum, are used for the different paces of Infantry in a minute?	Slow time .... 75 steps 24·96 Inches. Quick time... 108 ,, 12·03 ,, Wheeling time 120 ,, 9·8 ,, Double quick. 150 ,, 6·26 ,,
WHAT is a ballistic Pendulum and its use?	A ballistic pendulum is a large block of wood, suspended so as to vibrate freely, into this block cannon shot are fired for the purpose of ascertaining their initial velocity.

Length of Pendulums to vibrate Seconds at every fifth Degree of Latitude.

Degrees of Latitude.	Length of Pendulum. Inches.	Degrees of Latitude.	Length of Pendulum. Inches.	Degrees of Latitude.	Length of Pendulum. Inches.
0	39·027	35	39 084	70	39·177
5	39·029	40	39 097	75	39·185
10	39·032	45	39 111	80	39·191
15	39·036	50	39 126	85	39·195
20	39·044	55	39·142	90	39 197
25	39·057	60	39 158		
30	39·070	65	39 168		

How do you find the length of a Pendulum to make any number of vibrations and vice versa?

Call the Pendulum, making 60 vibrations, the standard length; then, as the square of the given number of vibrations is to the square of 60; so is the length of the standard to the length sought. If the length of the pendulum be given, and the number of vibrations it makes in a minute be required; say as the given length is to the standard length so is the square of 60, its vibrations, in a minute, to the square of the number required. The square root of which will be the number of vibrations made in a minute.

ROPES.

How are ropes distinguished?

By their circumference, thus a Rope 2 inches in girt is called a two-inch rope.

How do you find the weight of a rope?

Multiply the length in fathoms by the square of the circumference, and divide the product by 480 for the weight in cwts.

How do you ascertain the strength of a rope to sustain a certain weight?

Square the circumference and divide by 5 for the number of tons which it will bear suspended from it.

Which is strongest tarred, or untarred, rope?

Untarred rope in constant use has been found $\frac{1}{3}$ more durable than the same when tarred.

Which stands exposure to wet best?

Tarred rope is stronger when exposed to wet or dry alternately.

Should a rope be tarred quite through or only superficially?

Rope superficially tarred is stronger and resists better the alterations of dryness and wetness, than when thoroughly soaked through with tar.

Which is the best tar for ropes, common or teak tar?

In 1805 an experiment was tried to determine whether any advantage would be derived from employing teak in preference to common tar: for this purpose two 3 inch ropes were prepared from the same yarns, and they were placed in the same store till 1807 when their strength were found to be as follows.

The common tarred Rope broke with 3848 lb.

The teak tarred Rope broke with 5980 lb.

How do you judge of the goodness of rope from its external appearance?

The color alone is not sufficient, as it depends on the water in which the hemp has been soaked, nevertheless grey or light color should be prefer-

red to greenish or yellow; when dark brown or spotted, it should be rejected, this indicates the hemp being rotten or too much steeped, strong scented hemp, is better than that which smells putrid mouldy or heated.

The strands should be of equal thickness and equally and firmly twisted, each forming a separate rope otherwise it will be weak and soon break.

A rope is defective when without having been used it appears rough, and some pieces of hemp are visible, this is caused by the threads being short, when squills and ends are in it the hemp has not been properly picked, in either of these cases the rope will not be so strong as it ought to be.

Of what use is old unserviceable rope?

Tarred rope is untwisted called junk, and made into wads and common rope yarn.

Untarred rope is picked to pieces, called oakum, and is very useful in packing ammunition.

What is coir rope?

Coir rope is made of the fibres of the cocoa-nut in India.

It stands salt water much better than any other kind of rope at any temperature above 40° and is therefore used as cables, in fresh water it soon rots and snaps.

The convexity of a coir cable is *upwards* whereas in all other kinds of cable it is *downwards*.

The following Tables, compiled from actual experiments, contain the Lengths, Weights, &c. of the Principal Ropes, Hawsers and Cables.

1st Weight, Dimensions, &c. of Ropes (Common made.)

Length.	Of 1 Inch or 9 Threads			Of 2 Inch or 33 Threads			Of 3 Inch or 75 Threads			Of 4 Inch or 132 Threads			Of 5 Inch or 204 Threads			Of 6 Inch or 300 Threads			Of 7 Inch or 403 Threads		
fathoms.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
1	0	0	0	0	0	0	0	0	1	0	0	2	0	0	4	0	0	6	0	0	8
2	0	0	0	0	0	1	0	0	3	0	0	5	0	0	8	0	0	12	0	0	17
3	0	0	1	0	0	2	0	0	5	0	0	8	0	0	13	0	0	19	0	0	26
4	0	0	1	0	0	2	0	0	6	0	0	11	0	0	17	0	0	25	0	1	7
5	0	0	2	0	0	3	0	0	8	0	0	14	0	0	21	0	1	4	0	1	15
6	0	0	2	0	0	4	0	0	10	0	0	17	0	0	26	0	1	10	0	1	24
7	0	0	3	0	0	5	0	0	12	0	0	19	0	1	2	0	1	17	0	2	5
8	0	0	3	0	0	5	0	0	13	0	0	22	0	1	7	0	1	23	0	2	14
9	0	0	4	0	0	6	0	0	15	0	0	25	0	1	11	0	2	2	0	2	23
10	0	0	4	0	0	7	0	0	17	0	1	0	0	1	15	0	2	8	0	3	3
15	0	0	6	0	0	10	0	0	25	0	1	14	0	2	8	0	3	12	1	0	18
20	0	0	9	0	0	14	0	1	6	0	2	0	0	3	3	1	0	17	1	2	7
25	0	0	11	0	0	17	0	1	14	0	2	14	0	3	24	1	1	21	1	3	22
30	0	0	14	0	0	22	0	1	23	0	3	1	1	0	19	1	2	25	2	1	11
35	0	0	16	0	0	25	0	2	3	0	3	16	1	1	12	1	3	1	2	2	26
40	0	0	19	0	1	1	0	2	12	1	0	1	1	2	7	2	1	6	3	0	15
45	0	0	21	0	1	4	0	2	20	1		15	1	3	0	2	2	10	3	2	2
50	0	0	23	0	1	9	0	3	1	1	1	1	1	3	23	2	3	14	3	3	18
55	0	0	25	0	1	13	0	3	9	1	1	15	2	0	17	2	3	18	4	1	6
60	0	1	0	0	1	16	0	3	18	1	2	2	2	1	11	3	1	23	4	2	22
65	0	1	2	0	1	19	0	3	26	1	2	16	2	2	4	3	2	27	5		10
70	0	1	5	0	1	24	1	0	7	1	3	2	2	2	26	4		3	5	1	26
75	0	1	7	0	1	27	1	0	15	1	3	16	2	3	19	4	1	7	5	3	2
80	0	1	10	0	2	3	1	0	24	2		2	3	0	14	4	2	12	6	1	2
85	0	1	12	0	2	6	1	1	4	2		17	3	1	7	4	3	16	6	2	18
90	0	1	14	0	2	11	1	1	13	2	1	3	3	2	2	5	0	20	7	0	6
95	0	1	16	0	2	15	1	1	21	2	1	18	3	2	23	5	1	24	7	1	22
100	0	1	19	0	2	18	1	2	2	2	2	3	3	3	18	5	3	1	7	3	9
105	0	1	21	0	2	21	1	2	10	2	2	18	4	0	14	5	0	5	8	0	24
110	0	1	23	0	2	24	1	2	18	2	3	6	4	1	12	5	1	9	8	2	11
115	0	1	25	0	2	27	1	2	27	3	0	0	4	2	5	5	2	13	8	3	27
120	0	1	27	0	3	5	1	3	9	3	0	5	4	2	26	6	3	19	9	1	19
122	0	2	2	0	3	7	1	3	12	3	0	10	4	3	3	7	0	3	9	2	7

Weight, Dimensions, &c. of Hawsers.

(Machine Made.)

Length.	Of 4 Inch or 108 Threads			Of 5 Inch or 156 Threads			Of 6 Inch or 228 Threads			Of 7 Inch or 312 Threads			Of 8 Inch or 408 Threads			Of 9 Inch or 516 Threads			Of 10 Inch or 648 Threads		
fathoms.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
1	0	0	3	0	0	5	0	0	8	0	0	11	0	0	14	0	0	18	0	0	22
2	0	0	7	0	0	11	0	0	16	0	0	22	0	1	0	0	1	8	0	1	17
3	0	0	11	0	0	16	0	0	24	0	1	5	0	1	15	0	1	26	0	2	12
4	0	0	15	0	0	22	0	1	4	0	1	16	0	2	1	0	2	17	0	3	7
5	0	0	19	0	0	27	0	1	12	0	1	27	0	2	16	0	3	17	1	0	2
6	0	0	22	0	1	5	0	1	20	0	2	10	0	3	2	0	3	25	1	0	25
7	0	0	26	0	1	10	0	2	0	0	2	21	0	3	17	1	0	15	1	1	20
8	0	1	2	0	1	16	0	2	8	0	3	4	1	0	3	1	1	16	1	2	15
9	0	1	6	0	1	21	0	2	16	0	3	15	1	0	17	1	1	24	1	3	10
10	0	1	10	0	1	27	0	2	4	0	3	26	1	1	4	1	2	14	2	0	5
15	0	2	1	0	2	26	1	0	8	1	1	25	1	3	20	2	2	3	3	0	7
20	0	2	20	0	3	26	1	1	21	1	3	24	2	2	8	3	1	1	4	0	10
25	0	3	11	1	0	25	1	3	5	2	1	23	3	0	24	4	0	18	5	0	12
30	1	0	3	1	1	25	2	0	18	2	3	23	3	3	13	4	3	15	6	0	16
35	1	0	22	1	2	24	2	2	2	3	1	22	4	2	1	5	3	4	7	0	18
40	1	1	12	1	3	24	2	3	14	3	3	21	5	0	17	6	2	2	8	0	21
45	1	2	3	2	0	24	3	0	26	4	1	20	5	3	5	7	1	19	9	0	23
50	1	2	23	2	1	24	3	2	11	4	3	20	6	1	21	8	0	17	10	0	26
55	1	3	14	2	2	23	3	3	23	5	1	19	7	0	9	9	0	6	11	1	0
60	2	0	5	2	3	23	4	1	8	5	3	18	7	2	26	9	3	3	12	1	4
65	2	0	19	3	0	23	4	2	20	6	1	17	8	1	14	10	2	20	13	1	6
70	2	1	5	3	1	2	5	0	4	6	3	17	9	0	2	11	1	18	14	1	9
75	2	1	19	3	2	1	5	1	16	7	1	16	9	2	18	12	1	7	15	1	8
80	2	2	25	3	3	21	5	3	1	7	3	15	10	1	7	13	0	5	16	1	15
85	2	3	16	4	0	20	6	0	13	8	1	14	10	3	23	13	3	22	17	1	17
90	3	0	8	4	1	20	6	1	26	8	3	13	11	2	11	14	2	19	18	1	20
95	3	0	27	4	2	19	6	3	10	9	1	12	12	0	27	15	2	8	19	1	22
100	3	1	18	4	3	20	7	0	23	9	3	12	12	3	16	16	1	6	20	1	25
105	3	2	9	5	0	19	7	2	7	10	1	11	13	2	4	17	0	23	21	1	27
110	3	3	0	5	1	18	7	3	19	10	3	10	14	0	20	18	0	12	22	2	1
113	3	3	12	5	2	8	8	0	16	11	0	16	14	2	8	18	1	20	23	0	16

Weights, Dimensions, &c. of Cables.

(Machine made.)

Length.	Of 7 Inch or 252 Threads			Of 8 Inch or 324 Threads			Of 9 Inch or 432 Threads			Of 10 Inch or 504 Threads			Of 11 Inch or 612 Threads			Of 12 Inch or 756 Threads			Of 13 Inch or 864 Threads		
fathoms.	cwt.	qrs.	lbs	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
1	0	0	9	0	0	12	0	0	17	0	0	19	0	0	24	0	1	1	0	1	6
2	0	0	19	0	0	25	0	1	6	0	1	11	0	1	20	0	2	3	0	2	12
3	0	1	1	0	1	10	0	1	23	0	2	3	0	2	16	0	3	5	0	3	18
4	0	1	11	0	1	25	0	2	12	0	2	23	0	3	12	1	0	7	1	0	24
5	0	1	21	0	2	8	0	3	1	0	3	15	1	0	9	1	1	9	1	2	3
6	0	2	3	0	2	20	0	3	18	1	0	7	1	1	5	1	2	11	1	3	9
7	0	2	13	0	3	5	1	0	7	1	0	27	1	2	1	1	3	13	2	0	15
8	0	2	23	0	3	18	1	0	24	1	1	19	1	2	25	2	0	15	2	1	21
9	0	3	5	1	0	3	1	1	13	1	2	11	1	3	22	2	1	17	2	3	27
10	0	3	15	1	0	16	1	2	3	1	3	3	2	0	18	2	2	19	3	0	6
15	1	1	9	1	2	24	2	1	4	2	2	19	3	0	27	4	0	0	4	2	9
20	1	3	3	2	1	4	3	0	6	3	2	7	4	1	8	5	1	10	6	0	12
25	2	0	25	2	3	12	3	3	7	4	1	22	5	1	17	6	2	20	7	2	15
30	2	2	19	3	1	20	4	2	9	5	1	10	6	1	27	8	0	2	9	0	18
35	3	0	13	4	0	0	5	1	11	6	0	16	7	2	8	9	1	11	10	2	21
40	3	2	7	4	2	9	6	0	12	7	0	14	8	2	17	10	2	21	12	0	24
45	4	0	1	5	0	7	6	3	13	8	0	2	9	2	26	12	0	3	13	2	27
50	4	1	23	5	2	5	7	2	15	8	3	18	10	3	7	13	1	13	15	1	2
55	4	3	16	6	0	23	8	1	16	9	1	5	11	3	11	14	2	27	16	3	5
60	5	1	10	6	3	13	9	0	18	10	2	21	12	3	26	16	0	4	18	1	9
65	5	3	2	7	1	21	9	3	19	11	2	9	14	0	7	17	1	13	19	3	12
70	6	0	26	8	0	2	10	2	21	12	1	25	15	0	16	18	2	23	21	1	15
75	6	2	20	8	2	10	11	1	22	13	1	12	16	0	21	20	0	5	22	3	17
80	7	0	14	9	0	18	12	0	24	14	1	0	17	1	7	21	1	15	24	1	21
85	7	2	8	9	2	26	12	3	25	15	0	16	18	1	16	22	0	24	25	3	24
90	8	0	2	10	1	6	13	2	27	16	0	4	19	1	25	24	0	6	27	1	27
95	8	1	24	10	3	14	14	0	0	16	3	20	20	2	6	25	1	16	29	0	2
100	8	3	18	11	1	23	15	1	2	17	3	8	21	2	15	26	2	26	30	2	5
101	9	0	0	11	2	8	15	1	20	18	0	0	21	3	12	27	0	0	30	3	12

EMBARKING ORDNANCE AND STORES.

What steps should first be taken in embarking Ordnance and Stores?

The first thing necessary, is, to prepare a list of all the articles to be embarked with the weight of each This list must have a large column for remarks.

Is there any difference in the tonnage of different articles?

The tonnage required for bulky articles will be generally $\frac{1}{7}$ more than their actual weight; but the tonnage of ordnance, shells, shot, &c. will be equal to their weight.

When Ordnance, &c. are embarked merely for the purpose of being transported from one place to another, how are they stowed?

Each ship should be stowed with as much as it will carry, and every article that relates to one particular species of Service or Ordnance, must be put on board the same ship; that in case one ship be lost, the others may remain in themselves complete.

When Ordnance, &c. are embarked for an expedition, how are they stowed?

With each piece of Ordnance must be placed every thing necessary for its service; its side arms, carriage limber, ammunition, &c. so as to be readily come at, when required to be disembarked.

How is a siege equipment stowed?

Not only every thing necessary for the service of the pieces of Ordnance should be arranged with them, but also every thing necessary for the construction of the battery on which they are to be mounted. It will be advisable in this case, to put different natures of Ordnance in the same ship, in proportion according to the service required of them.

How should the different articles be placed in the ship?

In general, it will be best to put the heavy articles in first; and every thing that is light, easy to be remov-

ed, or likely to be first wanted on the top.

Should the Ordnance be dismounted?

Previous to embarkation, the guns, carriages, waggons, &c. must be dismounted.

How should the different articles be marked so as to ensure every thing belonging to each piece, being forthcoming without confusion?

Give each piece of Ordnance and its carriage the same number, give the ammunition and other carriages different numbers from the ordnance carriages, then give every limber, whether of ordnance carriage, ammunition carriage, or, waggon, the number of its respective carriage. If for a simple transport, arrange the small stores, side arms, &c. according to their respective natures, but if for an expedition, every thing belonging to each particular piece of ordnance must be collected together, and the cases, or, chests in which they are put, marked with the number of the piece of ordnance to which they belong, their natures and description.

If their be any doubt of the different parts of the carriages being made with that uniformity so essentially necessary, every part which is separated must bear the number of its carriage, this precaution, at any rate, may be a good one, if the same vessel contains different natures of ordnance, or carriages.

Is it necessary to take off the axletrees of carriages when embarked?

The axletrees need not be taken off the carriages, if the vessels are of a sufficient size to admit them when fixed, as they are not easily replaced without workmen, and a tedious operation.

Should the wheels be taken off?

Yes, and placed either on each other, or, allowed to stand up according to room.

How should the carriage be placed with their axletrees on?

All carriages or waggons embarked with their axletrees fixed, must be arranged in the ship side to side, and, alternately front and rear, that their axletrees may not interfere with each other, and take too much room.

How are all the small articles of a dismounted carriage secured?

Such as elevating screws, linch pins, drag-washers, capsquares, &c. must be carefully collected and secured in a box marked with the description of stores, and number of the carriages to which they belong.

DISEMBARKING ORDNANCE AND STORES.

How should Ordnance, &c. be disembarked?

In disembarking Ordnance and stores, they must be landed exactly, in order, the reverse of what they were shipped; the carriages and waggons must be mounted as soon as possible, and every nature must be arranged as far from the shore as possible, to prevent confusion. If the disembarkation takes place in the presence of an enemy, the vessels of course must be loaded accordingly; and the field ordnance, with their carriages, ammunition, &c., must be so arranged as to be first landed, and with the greatest ease possible; in this case, the entrenching tools must also be kept in the greatest readiness.

VENT.

What is the size of the vent of a piece of Ordnance?

In all pieces of Ordnance the vent is $\frac{2}{10}$ of an inch in diameter. This is rather small for field ordnance.

Guns are constantly misfiring and the vent gets choked up, with part of the cartridge bag driven into it, which would not happen if the vent was a little larger, or at all events it would be much easier cleared.

On the other hand, the larger the vent the more of the powder will escape through it, but for field ordnance the former inconvenience is the greatest, as guns are frequently for the time rendered useless by the vent being choked up.

How is a vent cleared when choked?

If it cannot be cleared with the priming wire or pricker, a gimblet is used called a bit.

When a vent runs by excessive firing how is it repaired?

All guns and howitzers have screws of copper made to fit into the place intended for the vent, about an inch or so in diameter, called a bouche, through this the vent is perforated; when injured in any way, this male screw can be withdrawn and a new one put in.

Why are bouches made of copper?

Because it has been experimentally ascertained that this metal stands excessive firing, better than any other.

CATTLE.

What description of Cattle are used in the Artillery service?	Horses chiefly in Europe. In India, horses, bullocks, camels, elephants and mules.
Why are horses not generally used in India?	On account of the expence, and scarceness of them; the Natives never use horses in draught, bullocks are in general use for carriage and draught.
What is the usual proportion for a horse to draw?	Never more than 3 cwt. besides the weight of the carriage.
In a team do all the horses draw alike?	No, the horses nearest the carriage drow more than those in front, and the longer the team, the less the leaders will have to draw, and consequently the more will fall to the share of the wheelers.

Total.

A team of 4 horses may draw
6 cwt. each....24
6..do..5......do.....30
8..do..4, 2 qrs. do.....36
12..do..4......do.....48

Is no deduction ever made for the weight of the carriage?	Yes, in heavy carriages, it is usual to reckon all their weight beyond 12 cwt. as part of the load.
At what rate do horses walk, trot, and gallop?	Military horses walk about 400 yards in 4½ minutes. Trot the same distance in 2 minutes 3 seconds, and gallop it in about 1 minute.
What proportion of horses are allowed for Field Artillery in Europe?	The following horses are required for Field Artillery on Foreign Service; the 18 Pounder and 8 Inch Howitzer requires each....10 horses.

The 12, 9, and heavy 6 pounder, and 24 pounders and $5\frac{1}{3}$ inch Howitzer each................8 horses.

The light 6 and heavy 3 pounder Gun, 12 pounder Howitzer and all other carriages belonging to a Field Battery each.............6 horses.

What number of horses are allowed in India to Field Artillery?

At Madras horses are only allowed for the Horse Artillery, their Ordnance consists of 9 and 6 pounders, 8 horses allowed to each 9 pounders, and 6 to each 6 pounder and ammunition waggon.

What weight can be carried by a horse or mule?

About 2 cwt, and he can draw as much as seven men, which is 189lb., but when assisted by a wheel carriage a horse or mule will draw about 3 cwt. for a length of time on a smooth plain or level road; but when in a hilly country one-fifth of the weight must be deducted.

What weight can be drawn by two horses or mules abreast?

Their strength being as it were united, they can draw about $7\frac{1}{4}$ cwt.

What will a bullock carry?

A good bullock will carry with ease 120lb.

How much will two bullocks draw?

1000lb. without the cart which weighs about 472lb.

What proportion of bullocks are allowed to Ordnance carriages?

See the Tables at the end of this Article.

How are bullocks fastened to Gun carriages?

By a yoke only, to which the trace chain is attached, side traces, of rope are now under experiment for the wheel bullocks which causes them to turn much better, the driver having more power over them.

Do the drivers ride or walk ?	The wheel driver sits on the limber board, the other drivers walk each between his pair of bullocks.
How are camels used ?	In carrying ammunition, sometimes a Howitzer, never in draught.
How much will a camel carry ?	As much as three bullocks.
How are elephants used ?	In carrying ammunition, a 6 pounder can be carried on a good strong elephant, they are never used in draught.
How much will an elephant carry ?	As much as three Camels.

Madras Bullock Table.

G. O. by G. No. 12, 12th January 1831.

	In the Field.			From Station to Station		
	In Yoke.	Spare.	Total.	In Yoke.	Spare.	Total.
Iron Gun Carriage and Limber............ 24 Pounder.	44	9	53	26	5	31
,, ,, ,, ,, ,, dismounted... ,,	20	4	24	12	2	14
,, ,, ,, ,, ,, ...18 Pounder.	38	8	46	24	4	28
,, ,, ,, ,, ,, dismounted... ,,	18	4	22	10	2	12
,, ,, ,, ,, ,, ...12 Pounder.	30	6	36	18	3	21
,, ,, ,, ,, ,, dismounted... ,,	14	3	17	8	2	10
,, Howitzer ,, ,, ...10 Inch. }	Carriage not fixed.					
,, ,, ,, ,, dismounted... ,, }						
,, ,, ,, ,, ... 8 Inch.	26	5	31	16	3	19
,, ,, ,, ,, dismounted... ,,	16	3	19	10	2	12
Brass Gun Carriage and Limber............12 Pounder.	12	2	14			
,, ,, ,, ,, ,, dismounted... ,,	6	1	7			
,, ,, ,, ,, ,, ... 9 Pounder.	10	2	12			
,, ,, ,, ,, ,, dismounted... ,,	6	1	7			
,, ,, ,, ,, ,, ... 6 Pounder.	8	1	9			
,, ,, ,, ,, ,, dismounted... ,,	6	1	7			
,, ,, ,, ,, ,, ... 3 Pounder	6	1	7			
,, ,, ,, ,, ,, dismounted... ,,	4	1	5			
,, Howitzer Carriage and Limber.... ...... 8 Inch.	14	2	16			
,, ,, ,, ,, dismonnted... ,,	10	2	12			
,, ,, ,, ,, heavy....... $5\frac{1}{2}$ Inch.	10	2	12			
,, ,, ,, ,, dismounted... ,,	6	1	7			
,, ,, ,, ,, medium. .... $5\frac{1}{2}$ Inch.	8	2	10			
,, ,, ,, ,, dismounted... ,, }	6	1	7			
,, ,, ,, ,, medium. .... $5\frac{1}{2}$ Inch. }						
,, ,, ,, ,, ...12 Pounder.	8	2	10			
,, ,, ,, ,, dismounted... ,,	6	1	7			
Ammunition Waggon Horse Artillery laden............	10	2	12			
,, ,, ,, empty....	6	1	7			
,, Cart Foot Artillery laden.............	4	1	5			
,, ,, ,, empty..	2	1	3			
Transport Carriage spare............	14	2	16			
(With Iron Guns it will have the same number of Cattle allotted to those several Calibres mounted.)						
Mortar Cart spare........	6	1	7			

Madras Bullock Table, continued.

	In the Field. In Yoke.	In the Field. Spare.	In the Field. Total.	From Station to Station. In Yoke.	From Station to Station. Spare.	From Station to Station. Total.
When laden it will have Additional Cattle in the following proportions.						

ADDITIONAL CATTLE.

	Mortar.	Bed.	Total.
10 Inch Brass	6	6	12
8 ,, ,, ...	2	4	6
5½ ,, ,, ...	1	1	2

Spare Cattle 1 to 5.

	In the Field. In Yoke.	In the Field. Spare.	In the Field. Total.	From Station to Station. In Yoke.	From Station to Station. Spare.	From Station to Station. Total.
Forge Cart—loads at 400 lb. per Bullock.. .... { empty. ...... laden.	4	1	5			
Artificers Cart—loads at 400 lb. per Bullock .. { empty. ...... laden.	4	1	5			
Gun and Mortar Platforms, Gins, &c. &c. being carried on Platform or Country Carts will be laden as far as practicable in the following proportions, also in the removal of Stores from Station to Station.						
For a Country Cart .... lb. 800				2		
For a new pattern Store .... ,, 800				2		
For a Platform Cart .... ,, 700				2		
For a Platform with .... ,, 1200				4		

The above Table is calculated at the rate of 240lbs. weight for Iron Ordnance in the Field, and at 400lbs. for occasional movement. For Brass Ordnance the calculation is 400lbs. weight, whether for Field Service or occasional movement.

Bombay Bullock Table.—1830.

One of each Description.			Numbers for Field Service. In Yoke.	Spare.	Total.	Numbers for occasional removals. In Yoke.	Spare.	Total.	Remarks.
Iron Ordnance.									
Upon a Field or Transporting Carriage.	Long Guns.	24 Pdr..	40	8	48	32	4	36	
		18 ,,	36	7	43	26	4	30	
		12 ,,	30	6	36	22	3	25	
Upon a Transporting Carriage.	Mortars . . .	13 Inch..	34	7	41	24	3	27	
		10 ,,	36	7	43	26	4	30	with bed.
		8 ,,	18	4	22	14	2	16	,, ,,
Upon a Transporting Carriage.	Beds......	13 ,,	40	8	48	32	4	36	
		10 ,,	20	4	24	16	2	18	
On a Cart......................		8 ,,	8	2	10	6	2	8	
On a Field Carriage.	Howitzers.	10 ,,	36	7	43	26	4	30	
		8 ,,	26	5	31	20	3	23	
Brass Ordnance.									
Upon Field Carriage.	Field.	18 Pdr..	18	4	22	16	2	18	
		12 ,,	14	3	17	12	2	14	
		9 ,,	12	2	14	10	2	12	
		6 ,,	8	2	10	6	2	8	
Medium.	Gun Howitzer.	24 ,,	14	3	17	12	2	14	
		12 ,,	8	2	10	6	2	8	
		24 ,,	12	2	14	10	2	12	
	Howitzer.	10 Inch..	30	6	36	22	2	24	
Heavy		8 ,,	16	3	19	14	2	16	
Light		5½ ,,	14	3	17	12	2	14	
		5½ ,,	8	2	10	6	2	8	
		4⅖ ,,	8	2	10	6	2	8	
On Platform Carts.	Mortars . . .	10 ,,	12	2	14	10	2	12	
		8 ,,	4	1	5	4	0	4	
On Platform Carts.	Beds Wooden	10 ,,	12	2	14	10	2	12	
		8 ,,	6	2	8	4	2	6	
Loaded	Ammunition Carriage with Limber		8	2	10	6	2	8	
	Forge do.	do.	8	2	10	6	2	8	
Platform Cart..............		1000 lbs.	6	2	8	6	1	7	
do. do. carrying......		750 ,,	4	2	6	4	1	5	
do. do...............		450 ,,	4	1	5	4	0	4	

Bombay Bullock Table.—1830, continued.

One of each Description.	Number for Field Service.			Numbers for occasional removals.			Remarks.
	In Yoke.	Spare.	Total.	In Yoke.	Spare.	Total.	
Spare Carriages.							
Transporting........................	14	3	17	12	2	14	
Heavy..................24 Pdrs.	12	2	14	10	1	11	
Do.........................18 & 12 ,,	10	2	12	8	1	9	
Iron Howitzer...........10 Inch.	14	3	17	12	2	14	
Do. do.............. 8 ,,	12	2	14	10	1	11	
Brass do...............10 ,,	12	2	14	10	1	11	
Do. do............... 8 ,,	10	2	12	8	1	9	
Field.....................18 & 12 Pdrs.	10	2	12	8	1	9	
Do....................... 9 & 6 ,,	6	1	7	6	0	6	
Howitzer heavy .... 5½ Inch.	8	2	10	6	1	7	
Do. light.......... 5½ & 4⅖ ,,	6	1	7	6	0	6	
Ammunition and Forge Carriage	6	1	7	4	1	5	
Platform Carts........	4	0	4	4	0	4	
Pack Bullocks.							
Each to carry { Loose Shots or Shells. .... 120 lbs. Of other Stores. .... 140 ,, } Of Grain they carry generally 160 lbs.							
Spare to the above ⅙ of the whole on Service—and $\frac{1}{10}$ in ordinary.							

Bengal Bullock Table.

	In Yoke.	Spare.	Total.
Iron Gun with Carriage and Limber 24 Pounder	26	5	31
,, ,, spare ,, ,, ,, 24 ,, ..	16	3	19
,, ,, with ,, ,, ,, 18 ,, ..	22	4	26
,, ,, spare ,, ,, ,, 18 ,, ..	14	3	17
,, ,, with ,, ,, ,, 12 ,, ..	18	3	21
,, ,, spare ,, ,, ,, 12 ,, ..	12	2	14
Brasss ,, ,, ,, ,, 12 ,, ..	10	2	12
,, ,, ,, ,, ,, 6 ,, ..	6	1	7
,, howitzer ,, ,, ,, 8 Inch ..	10	2	12
,, ,, ,, ,, ,, hr. 5½ ,, ..	8	1	9
Ammunition Waggon.........................	6	1	7
Transport Carriage..........................	16	3	19
Mortar Cart.....................................	6	1	7
Artificers ,, ...	10	2	12

THE TANJORE MAHARAJA SERFOJI'S SARASWATI MAHAL.

HEIGHTS AND DISTANCES.

The accurate determination of the heights and distances of objects being of the utmost importance in a variety of Military operations, the problems for their attainment should consequently be certain, simple, and expeditious.

In all problems for this purpose, the distances or altitudes are considered as accessible or inaccessible.

Accessible distances are measured by applying to them a certain determinate standard, as an inch, a foot or a yard, but inaccessible distances can only be ascertained by taking angles, or by some such like method drawn from the principles of Geometry.

When instruments are used to measure the magnitude of the angles, the unknown quantities are computed trigonometrically. In the other methods, they are computed on the principles of similar triangles, or some other simple geometrical property, without any regard to the measure of the angles. The instruments usually employed for measuring angles in the Field, are the Pocket Compass, and Sextant. These instruments, cannot, however, at all times be procured; but the following mechanical problems, if properly applied, will, to a certain extent, render an Officer independent of them.

HEIGHTS.

CAN the height of an object be taken by its shadow ?

Yes ;—by setting up vertically a staff of known length, and measuring the length of its shadow upon a horizontal or other plane ; measure also the length of the shadow of the object of which the altitude is required.

Then, by the property of similar triangles ; Say, as the length of the shadow of the staff,

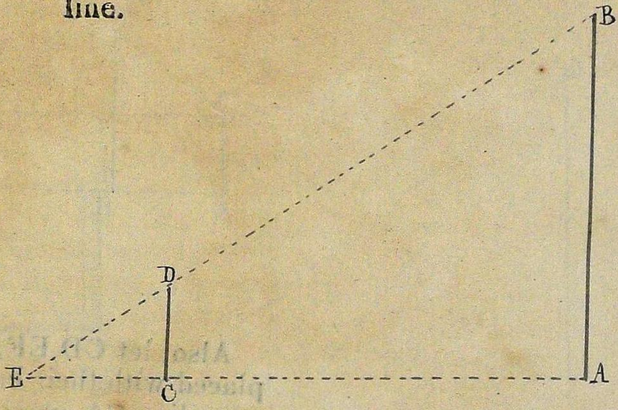
Is to the altitude of the staff ;

So is the length of the shadow of the object,

To the altitude of the object.

BUT if there be no shadow, how can you ascertain the height of an object ?

Let C. D. be a staff equal in length to the height of the observer's eye, and let it be set up at C, at such a distance from the foot of the required altitude, that the observer, having laid himself upon his back, with his feet against the bottom of the stick, may see the tops of D, and B, of the staff and object appear in the same line.



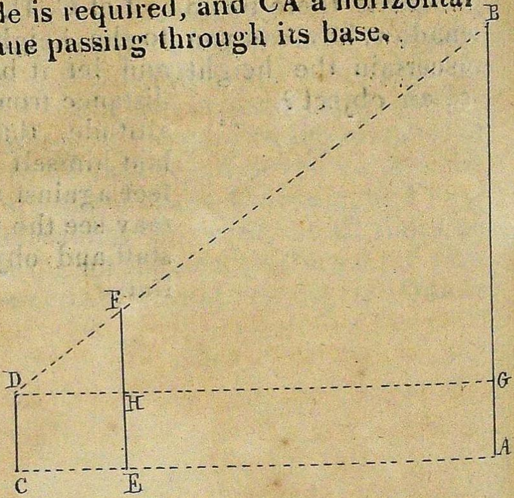
Then by similar triangles, AE, is equal to AB, because, by construction, CE is made equal to CD.

Or, the stick may be of any convenient length, for the distance from its foot to the eye of the observer will always be in the same proportion to its height, as the whole distance is to the altitude of the object required.

Can the height of an object be taken by two staves of unequal lengths?

Yes:—let two staves, one 6 feet, and the other 4 feet long, be placed upon horizontal, circular, or square feet, on which each may stand steadily.

Then, let AB, be the object, as a tower or steeple, of which the altitude is required, and CA a horizontal plane passing through its base.



Also, let CD, EF, the two rods, be placed with their bases in one and the same line CA, passing through A, the foot of the object; and let them be

moved nearer to, or farther from each other, until the summit B of the object is seen in the same line as D and F, the tops of the rods.

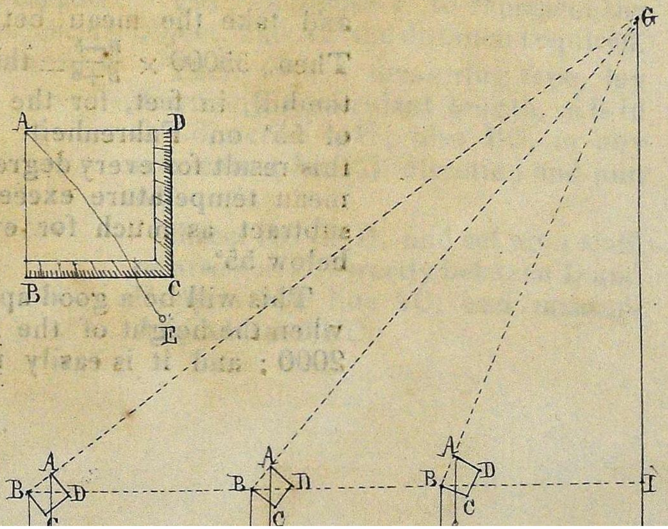
Then, by the principle of similar triangles, it will be, As DH (=CE) : FH :: DG(=CA) : BG. To which add AG=CD for the whole height AB.

Thus supposing CE, to be 6 feet; FH 2 feet, and CA 150 feet, the proportion will be, As 6 : 2 :: 150 : 50 feet.

Then 50+CD will be the altitude required.

Can the height of an object be ascertained by means of the Geometrical Square, or Plummet?

Yes;—let A,B,C,D, be a square, A,E a plummet suspended from one corner A, and let each of the two sides, BC,CD, meeting in the opposite angle, C, be divided into 10, 100, or 1000 equal parts. Also, let two sights be fixed on the side, AB: Then it is evident, that, in taking any altitude FG, with the square, the plummet will always cut off from it a triangle similar to that formed by the base line BI, the perpendicular IG, and the line of sight BG, of the object.



Consequently, if G,B,I be an angle of 45°, the plumb line will pass through the opposite angle, C, of the square, and the distance BI=HF will be equal to IG, which being added to IF=BH will give GF, the altitude.

Also, if the angle be greater than 45°, as in the right hand figure, then, by similar triangles, the part of the side cut off from BC, will be to the whole side, AB, as BI to IG ; so that if the part cut off from BC, be 8 divisions, of which AB is 10, and the distance LF be 36 feet, it will be.

As $8 : 10 :: 36 : \frac{360}{8} = 45$ feet. To which add, FI for the altitude.

CAN heights be ascertained by means of a Portable Barometer, and Thermometer?

Yes;—observe the altitude, B, of the mercurial column, in inches, tenths, and hundredths, at the bottom of the hill, or other object, the height of which is required.

Observe also, the altitude *b*, of the mercurial column at the top of the object.

Observe the temperature on Fahrenheit's thermometer at the times of the two barometrical observations, and take the mean between them. Then, $55000 \times \frac{B-b}{B+b} =$ the height of the hill, in feet, for the temperature of 55° on Fahrenheit. Add $\frac{1}{440}$ of this result for every degree which the mean temperature exceeds 55°, and subtract as much for every degree below 55°.

This will be a good approximation when the height of the hill is below 2000; and it is easily remembered,

because 55°, the assumed temperature, agree with 55, the effective figures in the co-efficient; while the effective figures in the denominator of the correcting fraction, are two fours.

DISTANCES.

Can the breadth of a River be ascertained by means of two pickets?

Yes;—take two pickets of unequal lengths, drive the shortest into the ground, say close to the edge of a river; measure some paces back from it, and drive in the other till you find, by looking over the tops of both, that your sight cuts the opposite bank.

Next, pull up the first picket, measure the same distance from the second, in any direction the most horizontal, and drive it as deep in the ground as before.

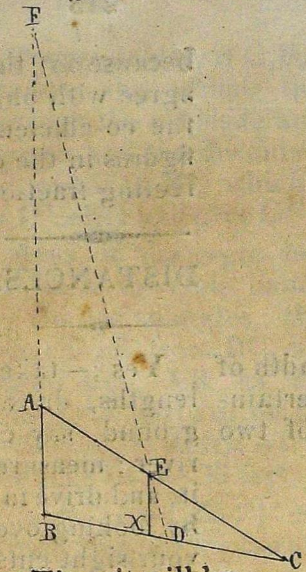
Then, if you look over them again, and observe where the line of sight falls, you will have the distance required. This method is, of course, applicable only to very short distances.

Cannot the breadth of a River be ascertained by means of a triangle?

Yes;—suppose F to represent the object, and AF the distance required.

Then, with a measuring tape, lay down any convenient length, AB in the direction AF; also BC, in any convenient lateral direction and join AC.

Bisect BC in D, and set up a staff, or arrow at E, directly between D and F, upon the line AC, and measure AB, AE, and EC.



Then it will be,

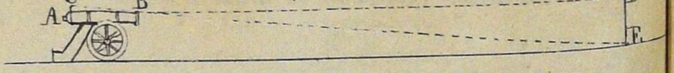
As CE—EA : EA : : AB : AF. The distance required.

Thus supposing AB to be 60 feet, AE 50 feet, and EC 80 feet, the proportion will be,

As 80—50 : 50: : 60 : 300 feet.

CAN the breadth of a River be ascertained by the Tangent Scale of a Gun ?

Yes ;—lay the Gun by the line of metal AB, for the top of the object D, then raise the scale AC, till the top of it C, and the notch B, on the muzzle, are in line with the foot E, of the object, and note what length of scale is required.



Then, by similar triangles, it will be.

As AC : AB :: DE : BD. The distance required.

Thus, supposing the height, DE, of the object to be 6 feet, the length of C of the Tangent Scale 3 inches; and of the Gun 5 feet, 6 inches, the proportion will be,

As 3 :: 66 :: 72 : 1524 inches, or 132 feet.

It will be perceived that this method supposes the third term of the proportion, DE, to be known.

MAY not the breadth of a River be ascertained by means of a Rhombus?

Yes;—suppose F the object, and AF the required distance, as in the second problem. With a line or measuring tape, of a length equal to the side of the intended rhombus, the longer the better, lay down one side, AB in the direction, AF, and also with a second tape, BC, another side, in any convenient direction,—for whether B be a right angle or not, is of no consequence: and put up two rods or arrows at A and C.

Then fasten two ends of two such lines at A and C, and extend them until the two other ends just meet at D. Let them be thus stretched upon the ground, and they will form the other two sides AD,CD, of the rhombus.

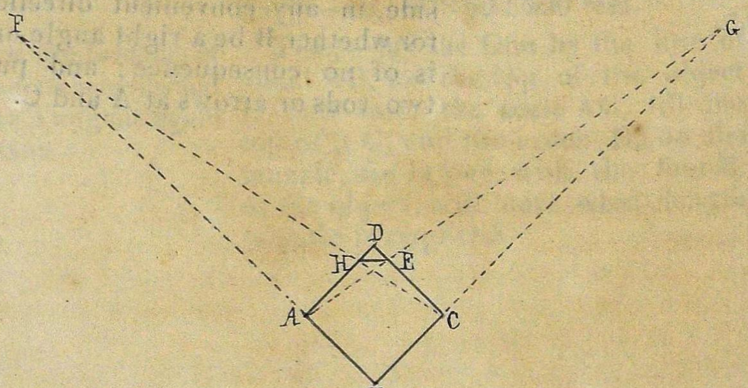
Next, fix a mark or arrow at E, directly between C and F, upon the line AD, and measure AE, and ED, upon the tape.

Then, by the property of similar triangles, it will be,

As ED : CD :: AE : AF. The distance required.

When the distance between two inaccessible objects is required what is done ?

In this case, let F and G represent the objects, and FG the required distance. At some convenient point, B, lay down the rhombus, ABCD, so that two of its sides, BA,BC, be directed to the extremities of the line, FG.



Next mark the intersections, E and H, of AG, CF, with the sides of the rhombus as in the case above; and the triangle, HDE, will be similar to the triangle GBF, and EH parallel to FG. Then by similar triangles it will be.

As ED : DA :: BA : BG.

And DH : EH :: BG : FG. The distance required.

Are there any Instruments by which distances may be computed?

Yes,—Portable Instruments have been invented by Martin, Cavallo, Dolland, Brewster, and others, for the purpose of measuring extremely small angles. In employing them for the determination of distances, all that is necessary in practice is to measure the angle subtended by an object of known dimensions, placed either vertically or horizontally at the further extremity of the line, the length of which we wish to ascertain.

Thus, if there be a house or other erection built with bricks of the usual size, then four vertical courses are equal to a Foot, and four horizontal courses to a yard; and distances measured by means of these will be tolerably accurate, if care be taken, when observing the angle subtended by the horizontal object to stand directly in front of it. A man, a carriage wheel, a window, a door, &c. at the further extremity of the distance we wish to ascertain, may serve for an approximation; but in all cases where it is possible, let a foot, a yard, or a six feet measure, be set up vertically, at one end of the line to be measured, while the observer, with his micrometer, stands at the other.

Then, if *h* be the height of the object, either

$\frac{1}{2}$ h×cot $\frac{1}{2}$ angle subtended, or, cot angle will give the distance, according as the eye of the observer is horizontally opposite to the middle, or to one extremity of the object.

When a table of natural tangents is not at hand, a very near approximation for all angles less than half a degree, and a tolerably near one up to angles of a degree, will be furnished by the following rules :

1st: If the distant object, of which the angle is taken be one foot length.

Then,

3437.73÷the angle in minutes
or 206264÷the angle in seconds. } will give the distance in feet.

2d. If the distant object be 3,6,9, &c. feet in length, multiply the former result by 3, 6, 9, &c. respectively.

By means of the following table, which is calculated for every half minute up to one degree, the results of such angles as fall within those limits may be ascertained by inspection only.

Thus, suppose an extension of one foot is found by the table to subtend an angle of 22 minutes, the distance will be 156.2 feet ; and suppose at the distance 171.8 feet an object subtend an angle 20 minutes, its altitude will be one foot.

Again,–suppose an object 6 feet high to subtend an angle of 20 minutes, then by the rule, 171.8×6= 1030.8 feet will be the distance.

Table of Angles subtended by a Foot at different Distances.

Angles.		Distances.	Angles.		Distances.	Angles.		Distances.	Angles.		Distances.
min.	sec.	Feet.	min.	sec.	Feet.	min.	sec.	Feet.	min.	sec.	Feet.
0	30	6875.5	15	30	221.8	30	30	112.6	45	30	75.5
1	0	3437.7	16	0	214.8	31	0	110.9	46	0	74.7
1	30	2291.8	16	30	208.3	31	30	109.1	46	30	73.9
2	0	1718.9	17	0	202.2	32	0	107.4	47	0	73.1
2	30	1375.0	17	30	196.4	32	30	105.7	47	30	72.3
3	0	1145.9	18	0	191.0	33	0	104.2	48	0	71.6
3	30	982.2	18	30	185.8	33	30	182.6	48	30	70.8
4	0	859.4	19	0	180.9	34	0	101.1	49	0	70.1
4	30	763.9	19	30	176.1	34	30	99.6	49	30	69.4
5	0	687.5	20	0	171.8	35	0	98.2	50	0	68.7
5	30	625.0	20	30	167.6	35	30	96.8	50	30	68.6
6	0	572.9	21	0	162.7	36	0	95.5	51	0	67.4
6	30	528.9	21	30	159.9	36	30	94.2	51	30	66.7
7	0	491.1	22	0	156.2	37	0	92.9	52	0	66.1
7	30	458.3	22	30	152.8	37	30	91.6	52	30	65.4
8	0	429.7	23	0	149.4	38	0	90.4	53	0	64.8
8	30	404.5	23	30	146.3	38	30	89.3	53	30	64.2
9	0	382.0	24	0	143.2	39	0	88.1	54	0	63.6
9	30	361.9	24	30	140.3	39	30	87.0	54	30	63.1
10	0	343.7	25	0	137.5	40	0	85.9	55	0	62.5
10	30	327.4	25	30	134.8	40	30	84.8	55	30	61.9
11	0	312.5	26	0	132.2	41	0	83.8	56	0	61.4
11	30	298.9	26	30	128.4	41	30	82.4	56	30	60.8
12	0	286.5	27	0	127.3	42	0	81.8	57	0	60.3
12	30	275.0	27	30	125.0	42	30	80.9	57	30	59.8
13	0	264.4	28	0	122.7	43	0	79.9	58	0	59.2
13	30	254.6	28	30	120.6	43	30	79.0	58	30	58.7
14	0	245.5	29	0	118.5	44	0	78.1	59	0	58.2
14	30	237.0	29	30	116.5	44	30	77.2	59	30	57.7
15	0	229.2	30	0	114.6	45	0	76.4	60	0	57.3

LEVELLING.

How do you find the difference between the true and apparent level?

By the following table, is shewn the difference between the true and apparent level?

Distance.	Difference of Level.		Distance.	Difference of Level.		Distance.	Difference of Level.		Distance.	Difference of Level.	
yds.	In.	Pts.	yds.	Inch	Pts.	Mls.	ft.	Inch.	Mls.	feet.	Inch
100	0	026	1000	2	570	$\frac{1}{4}$	0	$0\frac{1}{2}$	7	32	6
200	0	103	1100	3	110	$\frac{1}{2}$	0	2	8	42	6
300	0	231	1200	3	701	$\frac{3}{4}$	0	$4\frac{1}{2}$	9	53	9
400	0	411	1300	4	344	1	0	8	10	66	4
500	0	643	1400	5	038	2	2	8	11	80	3
600	0	925	1500	5	785	3	6	0	12	95	2
700	1	260	1600	6	580	4	10	7	13	112	2
800	1	645	1700	7	425	5	16	7	14	130	1
900	2	081	0	0	0	6	23	11	15	150	0
									16	175	0

This table will answer several useful purposes.

How do you find the height of the apparent level, above the true, at any distance?

If the given distance be contained in the table, the correction of level is found in the same line with it; but if the exact distance be not found in the table, then multiply the square of the distance in yards by 2.57, and divide by 1,000,000, or cut off 6 places on the right, for decimals; the rest are inches; or, multiply the square of the distance in miles, by 66 feet 4 inches and divide 100.

How do you find the extent of the visible horizon, or, how

The height of the observers eye above the horizon being known, the extent of his visible horizon is found

far can be seen from any given height, on a horizontal plane, as at sea, &c.?

in the column opposite, under the word distances.

How do you find the distance of any object, when it first comes in sight, its height being known?

The distance of any object will be the extent of the visible horizon of the observer, added to the visible horizon of the point he observes. It is necessary in this case for the observer to know only the height of that part of the object which is kept from his view, by the curvilinear figure of the Globe. Knowing the distance of an object, its height may be known in the same manner.

How are you to find the height or distance of an object if it extends beyond the limits of the foregoing table?

If the distance be given divide it by 2, 3, or 4, till the quotient comes within the distance in the table; then take out the height answering to the quotient, and multiply it by the square of the divisor for the height required. But when the height is given, divide by one of these square numbers, 4, 9, 16, 25, &c. till the quotient comes within the limits of the table, and multiply the quotient by the square root of the divisor.

GRAVITY.

What is meant by gravity?

The term gravity denotes the natural tendency or inclination of all bodies towards the centre of the earth, and is divided into absolute and specific.

What is absolute gravity?

Absolute gravity denotes the whole force with which a body tends downwards.

What is specific gravity?

Specific gravity, the relative or comparative gravity of any body, in respect to that of another body of equal bulk or magnitude. It further denotes, that gravity or weight which is peculiar to each species or kind of body, and by which it is distinguished from all other species or kinds.

In this sense a body is said to be specifically heavier than another, when under an equal bulk or magnitude, its weight is greater than that other; and reciprocally, the latter is said to be specifically lighter than the former.

Table of the Specific Gravities of several solid and Fluid Bodies.

Air in a mean state	1 232	Charcoal	
Alder	800	Cherry-tree	715
Apple-tree	793	Citron	726
Ash the trunk	845	Clay	2160
Bay-tree	822	Coal	1250
Beech	852	Cocoa-wood	1040
Boxwood	1030	Copper	9000
Brass cast	8000	Cork	240
Brick	2000	Cypress Spanish	644
Campechy-wood	913	Earth common	1984
Cedar .. Wild	596	Ebony .. American	1331
Cedar .. Palestine	613	Ebony .. Indian	1209
Cedar .. Indian	1315	Elder-tree	695
Cedar .. American	561	Elm	671

Filbert-tree		600
Fir	Male	550
	Female	498
Flint		2570
Glass	Crystal	3150
	Common green	2600
Gold	Fine	19640
	Standard	18888
Gun Metal		8784
Granite		3000
Gun-powder	Solid	1745
	Closely shaken	958
	In a loose heap	868
Hazel		600
Iron	Wrought	7645
	Cast	7425
Ivory		1825
Jasmin Spanish		770
Juniper-tree		556
Lead		11325
Lemon-tree		703
Lignum-vitœ		1333
Linden-tree		604
Mahogany		1063
Maple		750
Marble		2700
Mastic-tree		849
Medlar do		944
Mulberry Spanish		897
Nitre		1900
Oak		950
Olive-tree		927
Orange-tree		705
Pear-tree		661
Pitch		1150
Platina pure		23400
Plum-tree		785
Pomegranate-tree		1354
Poplar		383
Quick-silver	Pure	23400
	Common	14000
Quince-tree		705
Rosin		1100
Sand		1520
Sassafras		482
Silver	Fine	11091
	Standard	10535
Steel		7850
Stone common		2520
Sulphur		1810
Tar		1015
Tin		7320
Vine		1327
Walnut		671
Water	Common	1000
	Rain	1000
	River	1009
	Sea	1030
Willow		585

These numbers being the weights of a cubic foot, or 1728 cubic inches of each, of the bodies in avoirdupois ounces, the quantity in any other weight, or the weight in any other quantity, may be readily found.

How do you find the magnitude of any body from its weight?

Say as the tabular specific gravity of the body;

Is to its weight in avoirdupois ounces;

So is one cubic foot, or 1728 cubic inches,

To its contents in feet or inches respectively.

How many cubic inches of gunpowder are there in a closely shaken mass weighing one pound ?

Here it will be,

As 958 : 16 :: 1728 : 28·7 cubic inches nearly. The content required.

How do you find the weight of a body from its magnitude ?

Say, as one cubic foot, 1728 cubic inches,

Is to the content of the body,

So is the tabular specific gravity,

To the weight of the body.

The walls of Balbeck are built of Marble, and one of the Blocks is 63 feet long, 12 feet in breadth and the same in thickness, required its weight ?

Here $63 \times 12 \times 12 = 9027$ cubic feet. The content of the block ;

Then it will be,

As 1 : 9072 :: 2700 : 24494400 oz. or $683\frac{7}{16}$ tons. The weight required.

FORCE OF GRAVITY.

The Earth being of an oblate spheriodal form, the force of gravity will be greater near the poles than at the equator ; and it is measured by the velocity generated in one second of time by a body falling from a state of rest. Let this velocity be expressed by 2 g, where g represents the space of a Body falls through during one second, then $f \propto g$. But when a body falls by the force of gravity, the spaces descended are proportional to the squares of the generated velocities. Therefore, let a body fall through equal spaces (s), by two different gravitating forces, represented by f and f or by g and g.

Then, $g : (2g)^2 :: s : 4\,sg$; and $g : (2g)^2 :: s : 4\,sg$.

But $4\,sg$ and $4\,sg$, which represent the velocities generated after describing equal spaces, are, evidently, to each other as g to g, that is, as the gravitating forces. Therefore $f \propto v^2$ when the spaces are equal.

Again, the velocity of a pendulous body, vibrating by the force of gravity, is equal to that acquired by a body falling through the versed sine of the arc of vibration; and if two pendulums are of equal length and describe equal arcs, the versed sines are equal, and f is proportional to the square of the velocity of the pendulum. But the number of vibrations performed in equal times is proportional to the velocity, therefore, the force of gravity in different places on the earth's surface is proportional to the square of the number of vibrations performed, by equal pendulums, in equal times.

The increase of the force of gravity from the equator towards the poles, is proportional to the square of the sine of the latitude; and according to Captain Sabine's experiments, the whole increase of the force of gravity at the pole beyond that at the equator is equal to ·20227, the force at the equator being expressed by unity.

CENTRE OF GRAVITY.

WHAT is the centre of gravity?

The centre of gravity of a terrestrial body or system of bodies, is that point through which if a plane be made to pass, and that plane be brought to a vertical position, the sum of the actions of gravity upon all the points or bodies situated on one side of the plane is equal to the sum of the actions of gravity upon all the points on the other side.

As the gravitating principle acts in lines passing through any given point, and the earth's centre and as these lines may be considered parallel to each other, without sensible error, within the limits of any system of bodies connected together for mechanical purposes, it follows that the centre of gravity of any body, or system of bodies, may be found by the theory of parallel forces.

From that theory it will follow that the centre of gravity of a right line is in the middle of its length; because the sum of the actions of gravity upon all the points on each side of its middle point will be equal to each other.

And for a like reason, the centre of gravity of a circle, of a regular polygon of a prism, of a cylinder, of a sphere, or of any regular body, is in its centre.

How do you find the centre of gravity in a Triangle?

The centre of gravity of a triangle, is found by bisecting any two of its sides, and drawing lines from the points of bisection to the opposite angles, the intersection of these lines will be the centre of gravity required.

For, suppose the triangle to be composed of an infinite number of right lines parallel to one of its sides, the centre of gravity of each line being in its middle, that of the whole figure will be somewhere in a line bisecting all those parallel lines, which will be the line drawn from the middle of another side to the opposite angle. For the same reason, the centre of gravity of the whole will be somewhere in a line drawn from the middle of another side to its opposite angle; therefore, it will be in the intersection of two such lines.

How is the centre of gravity found in two bodies?

The centre of gravity of two bodies is, from the theory of parallel forces, in a line joining the centre of gravity of both bodies, and is at a distance from each, inversely proportional to the masses or weights of the bodies respectively.

Thus, the common centre of gravity of two bodies, A and B, may be found by the following proportion, viz. the sum of the weights of A and B, is to the weight of A, as the distance of the centres of gravity of A and B, is to the distance of the common centre of gravity of the two bodies from that of B.

The centre of gravity of any irregular figure may be found by dividing it into triangles, finding the centre of gravity of each triangle separately, joining any two of those centres by a right line and finding the common centre of gravity of those two triangles by the proportion just mentioned; expressing the weights of the triangles by their areas which are proportional

to their weights, then joining this centre of gravity, and that of a third triangle, and finding the common centre of gravity of the three triangles as before, and so continuing, till the centre of gravity of the whole figure is found.

How is the centre of gravity found in a plane surface?

The centre of gravity of any plane surface may be found experimentally thus:--place the surface in two different positions on the edge of a prism, and move it about till it is in equilibrio, in both positions then draw lines upon the surface, coinciding with the edge upon which it rested in equilibrio, and the intersection of those lines will be the centre of gravity required.

How is the centre of gravity found in solid bodies?

In the same way the centre of gravity of a solid body may be found by balancing it in three different positions on the edge of a prism, and imagining vertical planes, to pass through the lines, on which the body is in equilibrio, for then the centre of gravity of the body will be the point of the common intersection of all the three planes.

GIN.

What is an Artillery Gin and its use?

An Artillery Gin consists of three poles united at the top, to which blocks and tackle are attached; between two of its legs when opened out is a windlass, usually worked by handspikes.

The use of the Gin is to mount and dismount heavy Guns from, and on their Carriages.

Working the Gin with handspikes is very tedious, and the Men are exposed when standing on the lower bar,—at the suggestion of Captain Bond of the Artillery two cog wheels at each end of the roller has been substituted, the operation of mounting and dismounting ordnance is done in much less time, and the Men are not exposed above the parapet. An Iron 18 pounder can be mounted and dismounted in $6\frac{1}{2}$ minutes; by Lombard's old Gin it took 29 minutes.

Dimensions and Names of the different parts of a Gin.

Names.	Weight. lb.	Weight. oz	Length. Feet	Length. In.	
1 Pry Pole..	118	4	17	6·5	Diameter 6 Inches.
2 Cheeks........	451	0	17	6·5	
Upper cross bar...	56	4	7	8	
Lower do. do..	94	0	11	0	
3 Shoes or fids....	73	0	1	8	
Windlass....	297	0	8	0	Diameter of large end 1 ft.; Length 4 ft. Do. small 7·5 in. do. 4 ft.
4 Handspikes	35	0	6	0	
2 Sheaved blocks..	57	0	1	4	Hook 11 Inches long.
3 do. do. ..	71	0	1	4	Do. 12 do. do.
Tackle bolt..... ..	29	4	2	6	
Do. loop......	50	0	1	10	
Rope.............	90	8	120	0	
Total..	1322	4	0	0	

WHAT is a Jack and its use?

A Jack is a common screw fixed into any convenient frame. The screw may be of any size usually about that of an elevating screw, its common use is, to be applied to the axletree of a Carriage to raise and support it when a wheel is taken off or greased.

MECHANICS.

WHAT do you understand by Mechanics?

Mechanics is the science which treats of the actions and effects of moving bodies upon one another, or it is the science of equilibrium and of motion.

WHAT are the mechanical powers?

The mechanical powers are those simple machines by means of which any force may keep in equilibrio one which is greater than itself; and one or more of these enters into the composition of every compound machine.

How many powers are there?

Seven, viz.—The lever, the wheel and axle, the pulley, the inclined plane, the wedge, the screw, and the funicular machine.

THE LEVER.

How many kinds of levers are there?

Four.—The first is that in which the rod is supported, in some part of its length, on a fulcrum, and the moving and resisting powers are at opposite ends of the rod, as in the case of elevating a Gun by means of a hand-spike, where the resistance to be overcome is the Gun; the cheek of the carriage, the fulcrum; and the man the moving power.

FIRST kind.

SECOND kind.

The second, is that in which one end of the rod rests on the fulcrum, the moving power is at the other end, and the resistance is in some part of the length of the rod. This power is illustrated in the action of running up a Gun after recoil, where the platform represents the fulcrum, the Gun and carriage the resistance, and the man the moving power.

THE third. The third, is that in which one end rests on the fulcrum, the resistance is at the other end, and the moving power in some part of the length, which may be illustrated in the action of raising scaling ladders against the ramparts of a place; for here the ground is the fulcrum, the weight of the ladder the resistance, and the detachment raising it the power.

THE fourth. The fourth is like the first, only the rod is bent for convenience, and the fulcrum is at the angular point.

The moving and resisting powers are supposed to act in all cases perpendicularly to the lengths of the arms of the levers to which they are respectively applied.

The levers, also, are considered as without weight, or their arms to be in equilibrio before the weights are applied.

How is the power of a lever calculated? In the first lever, by the theory of parallel forces; when an equilibrium subsists, the power, is to the resistance, as the distance of the point of application of the resistance from the fulcrum, is to the distance of that of the power from the fulcrum; or the power multiplied into its distance from the fulcrum is equal to the product of the resistance into its distance from the same point.

The same rule holds good for the other three kinds of levers, because, in all the four cases, the power, resistance, and pressure on the fulcrum, are three forces expressed by the same terms, but reciprocally interchanging values with each other, and of which

one is always equal and acts in a direction opposite to those of the other two.

When the directions of the power, and resistance are not perpendicular to the arms of the lever, lines must be drawn from the fulcrum perpendicularly upon the lines of direction of the forces, and then the former proposition will hold good, if the distances of the forces from the fulcrum are measured on these perpendiculars.

If the arms are not in equilibrio when the forces are applied, multiply the weight of each arm into the distance of its centre of gravity from the fulcrum, and add each product to the like side of the former equation. The sum will form an equation from which the moving power may be found.

If a number of levers be combined together the power at the end of the first arm is to the resistance at the end of the last, as the product of all the short arms is to the product of all the long arms.

THE WHEEL AND AXLE.

What is the power of a wheel and axle?

This power forms a machine analogous to a lever of the first kind, the fulcrum being at the centre of motion. Therefore, in the case of equilibrium, the power, is to the resistance, as the radius of the axle, to the radius of the wheel; or, as the circumference of the axle, is to the circumference of the wheel.

How is the power of the wheel calculated?

If two or more wheels and axles are combined together by strings, or by teeth cut in their circumferences the power at the circumference of the first wheel, is to the resistance at the circumference of the last axle, as the product of the radii of all the axles, is to the product of the radii of all the wheels; or, as the continued product of the number of teeth in each axle, to the continued product of the number of teeth in each wheel, supposing every wheel and axle to have teeth.

THE PULLEY.

What is the power of the pulley?

A moveable pulley is analogous to a lever of the second kind, the fulcrum being at the fixed extremity of the rope, the power applied at the other extremity and the resistance at the centre of the pulley. Then, when the two directions of the rope are both parallel to the same diameter of the pulley, the power, is to the resistance as the radius of the pulley is to its diameter, or as 1 to 2. And when several pulleys are combined in two blocks, the same ratio is repeated as often as there are pulleys, in the moveable block; therefore if n represent the number of pulleys in the latter, the power, is to the resistance, as 1 to 2 n, so that if n=3, we have the power to the resistance as 1 to 6.

If a number of strings be made fast to immoveable points at one end, and each be made to pass under a moveable pulley, and the other end be at-

tached to the block of the next pulley, and so on; then if a resistance be applied to the first block, and a power at the extremity of the last rope, the system will be analogous to a compound lever, of the second kind.

Therefore, if n be the number of moveable pulleys, the ratio of the power to the resistance will be as 1 to 2 n, so that if $n = 3$ we, have the power to the resistance as 1 to 8.

THE INCLINED PLANE.

What is an inclined plane?

When a body is supported on an inclined plane, it is kept in equilibrio by three forces, viz. the power of gravity, the sustaining power, and the reaction of the plane; which all concurring in the body, the ratios between them are, by the composition of forces, proportional to three sides of a triangle coinciding with, or parallel to the directions in which the forces act.

When the sustaining power acts in a direction parallel to the length, or parallel to the base of the plane, the triangle of forces is similar to that formed by the hypothenuse, base, and perpendicular of the inclined plane; in the first case, the sustaining power is to the weight of the body, as the height of the plane is to the length of the hypothenuse; and, in the second case, the sustaining power is to the weight, as the height of the plane is to the length of the base.

THE WEDGE.

WHAT is the power of the wedge and how is it calculated?

This is analogous to an inclined plane, for on entering the material, the divided part seems to move along the slant side, as a body moves up an inclined plane. Therefore, if the impelling force be perpendicular to the head of the wedge, that force, together with the resistance and the reaction of the wedge form three forces in equilibrio, which will be proportional to the sides of a triangle, drawn parallel to, or coinciding with the directions in which the forces act. Consequently when the divided part turns on a joint at the angle of the wedge the impelling power, is to the resistance, as half the breadth of the head of the wedge, is to its slant length. And when the divided part moves in a direction parallel to the head of the wedge, the impelling power, is to the resistance, as half the breadth of the head of the wedge, is to its perpendiculer length.

THE SCREW.

WHAT is the power of the screw, and how is the power calculated?

When a screw, by turning on its axis, enters any material, the parts contiguous to the sides of the threads seem to move along the sides, just as a body moves up an inclined plane; Therefore, in the case of an equilibrium, the moving power acting as the circumference of the screw, is to the resistance in the direction of the

axis, as the distance between every two threads, measured in a direction parallel to the axis is to the circumference of the screw. But if a wheel or lever be fixed to the axis, as is the case with the elevating screw of a Gun, and the moving power be applied at the circumference of the one, or at the extremity of the other, the ratio of the circumference of the screw to the circumference of the wheel, must be compounded with that of the distance of the threads to the circumference of the screw, and the result will be, that the power is to the resistance, as the distance of the threads, to the circumference of the wheel.

THE FUNICULAR MACHINE.

What is a Funicular machine?

If a string be made to pass over two fixed pulleys, and a weight be applied to the string, in any position between the pulleys, and another weight at each of the two extremities, beyond the pulleys, the whole is called the Funicular Machine, and the ratio of the three weights can be found by forming a triangle with lines drawn parallel to, or coincident with the directions in which they pull from the points of application of the weight between the pulleys, therefore any one of them being unknown can be determined.

PONTOONS.

Of what materials are the pontoons in the British Service made?

The Pontoons used for forming Bridges in the British Service, are made of Tin.

Of what dimensions are pontoons usually made?

Pontoons are made from 16 to 26 feet in length, and from 2 feet 3 inches, to 4 feet 10 inches in breadth.

What weight will one of these pontoons support?

The common Pontoons will support a weight of 4 or 5000 lbs.

In forming a bridge how are pontoons usually placed?

In forming bridges, pontoons are generally placed about their width asunder.

How are bridges for passing rivers constructed in the French Service?

In the French Service pontoons have been abolished as unfit to make bridges over rivers where the current is rapid, and boats substituted in their places.

How are pontoon bridges generally laid?

In laying a pontoon bridge the banks of the river, where the ends of the bridge are to be laid, must first be made solid and firm by means of fascines or otherwise.

How are the pontoons then laid?

A cable is carried across the stream, and is fixed to a picket or any thing firm; it is there drawn tight by means of a capstan, and to this cable the heads of the pontoons are secured.

How many men are required for each pontoon?

In laying a pontoon bridge, two men are required for each pontoon.

If the river happens to be very rapid what precautions is it necessary to take?

If the river be very rapid a second cable must be stretched across the river parallel to the first, and at the distance of the length of the boats;

and to this the sterns of the pontoons must be lashed.

WHAT is next to be done in forming a pontoon bridge?

After every thing has been arranged as above directed, the spring lines are then lashed diagonally from one boat to another, and the anchors if necessary, are carried out up the stream and fixed to the cable that goes across the river.

WHAT is the last thing to be done in forming a bridge?

The last thing to be done in forming a pontoon bridge, is to place the chesses and baulks across the boats when the bridge will then be complete.

WHAT precautions ought to be taken when Troops are passing over a pontoon bridge?

Whatever size the bridge may be, Infantry should never be allowed to pass at the same time, with Carriages or Cavalry, and the latter should dismount and lead their Horses across.

WHAT precautions should be taken when Carriages pass a pontoon bridge?

The carriages should always move at a certain distance behind each other, that the bridge may not be shook by being overloaded.

WHAT is the best situation for placing a pontoon bridge which is intended to facilitate the communication at a siege?

When bridges are made to communicate between different parts of the approaches at a siege, they should if possible, be placed above the Town, or else the besieged will take advantage of the current, to float down large trees or other bodies, in order to destroy the bridge. If you are obliged to construct your bridge below the Town, it must be secured by a chain of piles.

How many bridges will be required to facilitate the communication at a siege?

Two bridges should always be placed close to each other, in order prevent the confusion of crossing and re-crossing on the same bridge, the one being intended to pass over one way, and the other to return.

WHAT precaution ought to be attended to in choosing that part of a river best adapted for constructing a pontoon bridge?

In the first place a bridge of this sort should not be constructed below any angle of the river which is covered with wood or rock, unless Centinals are placed to give timely notice of any attempt on the part of the enemy; and secondly all places ought likewise to be avoided where the banks are more than 4 or 5 feet above the level of the river.

ARE there any other precautions to be taken when constructing a pontoon bridge?

Yes; all positions where the opposite bank commands your own, and where the water is so shallow as to allow the boats to strike the bottom ought to be avoided; Care should likewise be taken that the opposite bank is free from rocks, bushes or any other thing that might cover an enemy from the fire of your own Troops or Artillery.

WHICH is one of the best situations for a pontoon bridge?

One of the most advantageous situations for a bridge of this kind is in a re-entering angle, for then the batteries for its defence will be in advance of the bridge, and will protect your Troops in advancing and retreating by their cross fire to a greater distance. If however the bridge is to be permanent, a re-entering angle is not a good position, as in the time of floods the current at the elbow opposite is apt to run with great rapidity.

WHAT methods may be adopted for forming temporary bridges when pontoons or boats are not to be had?

When pontoons or boats are not to be had, temporary bridges may be formed of tressells, Carriages or Waggons placed at certain distances and laid with baulks and chesses; or large gabions may be so placed as to let the water run through them, and the intermediate spaces filled up with

water fascines. Temporary bridges may also be formed by means of casks fastened together in pairs, and covered with baulks and chesses.

Is there any other method of forming a temporary bridge?

A temporary bridge may be constructed for the passage of Infantry, over a rivulet or ravine with high rocky margins by means of six or more cables stretched by Capstans from bank to bank. Over the cables slight chesses may be lashed at certain distances to support the ends of the hurdles or fascines which cover the platform.

What number of Men are required for the service of a Pontoon?

The Men required for the service of a pontoon are 14 and a Non-Commissioned Officer.

Are Pontoons in General use in India?

No, the rivers generally speaking are too rapid for them, and the expence and difficulty of conveying them is very great.

What is the usual mode of crossing Ordnance over rivers in India?

At Madras in basket boats made of common split bamboos and covered with raw hides. They are easily made, very light and easily managed.

Of what shape are basket boats?

Circular; bottom flat, sides nearly perpendicular usually about 15 feet in diameter.

How are Ordnance embarked in them?

The boat should be nearly filled with straw or other light soft material, a temporary wharf must be made with the planks of the platforms or other wood at hand, if the boat cannot be brought up close to the bank of the river.

How is a temporary wharf constructed?

If the boat is higher than the shore, it is to be brought as close to it as possible so that it can be made to float

when loaded, two sleepers are driven perpendicularly into the water close to the boat, the distance between them, that of the space of the wheels of the carriage to be embarked.

These uprights must be sufficiently high to allow the wheel or side planks of the platform to rest on them to form an inclined plane up which the carriage is run, the descent into the boat should be as easy as possible, the ends of the wheel planks towards the shore should be kept steady with strong pickets.

How is the Gun on its carriage run up the inclined plane or Wharf?

The wheels are run up on the side planks by hand, to prevent the Trail sinking a piece of wood is lashed across it resting on the side planks.

When the inclined plane is very steep how is the Gun run up?

Should the wharf be so steep that the Gun cannot be run up in the usual manner; fasten a drag rope round one of the lower spokes of each wheel, bring them on the tire towards the front, let them pass over the end of each wheel plank forming the inclined plane, and be brought back underneath to the rear, at which the hands must haul the piece up.

How is the Gun lowered into the boat?

The piece being run up the inclined plane, must be gradually lowered into the boat, either by hand or by drag ropes, the wheels will be nearly level with it, the cross bar at the trail must be removed, and the trail itself kept up by hand, the soft substance in the boat will prevent any part of the carriage making a hole thro' the boat. Care must be taken when the wheels clear the wharf, that the weight in front does not preponderate so as to

cause the gun to turn over, this must be prevented by the Men at the Trail, who must keep a sharp look out.

How are Guns embarked without Carriages?

The piece is placed lengthways across the wharf, the breech resting on one sideplank and the muzzle on the other, a rope fastened round or near each of those parts, these ropes pass over the ends of the wheel planks and are brought back to the rear for the Men to haul at, in the same manner as directed above for mounted guns that cannot be run up by hand, handspikes are also used if required, this is called par buckling.

How are Guns dismounted lowered into the boat?

When the gun has reached the top of the inclined plane the men still hold on at the ropes, other ropes are secured to the piece, the ends brought to the rear and both are gradually eased off till the piece is fairly in the boat.

What sized boat will convey an 18 Pounder mounted?

One of 18 or 20 feet diameter.

Are there no other means of crossing ordnance over rivers?

Rafts of Trees are used for this purpose--flying bridges at fixed points, and boats are sometimes carried by men, with armies, during the late Mahratta war, six small boats were so conveyed with the Poonah division, they accompanied the advanced guard, when placed in the water, they were lashed two and two, by this means the light ordnance used to be conveyed across any common river that was not very rapid, with little or no delay, the boats were always ready when the line came up.

RECONNOITERING.

WHAT precautions should be taken by an officer setting out to reconnoitre a Country?

Before an officer sets out to reconnoitre a country, he should. first trace out from the best plan he can procure, its principal features He should likewise have a small sketch book, on the right hand side of which sketches of the country may be made, and on the other side remarks, such as the names of towns, their distances asunder, &c.

WHAT is the best scale for a sketch book?

The best scale for a sketch book is 2 inches to a mile: if therefore the book is made 6 inches wide, and the leaves divided by lines into three equal parts each division will be one mile.

WHAT are the principal points to be attended to in reconnoitering?

The principal points to be attended to in reconnoitering are the state of the different roads, fords, inundations, springs, and wells, lakes, marshes and swamps, woods, and forests, heaths, canals, rivers, passes, ravines, bridges, mountains, hills, coasts, fortresses, towns, and villages.

WHAT is to be attended to with respect to Roads?

The principal points to be attended to with respect to roads is their direction; the villages, countries, and rivers. through which they pass, and whether they are passable for Artillery, &c. observe also of what materials their bottoms are formed, and the nature of the enclosures, whether they consist of Walls, hedges, &c.

WHAT is to be observed with respect to fords?

What ought principally to be attended to with respect to fords, are the banks on each side; their bottom, whether it is practicable for carriages; from what points it may be de-

fended, &c. Remark also the depths of Water, its rapidity, &c.

What is the greatest depth a ford is passable at?

A Ford to allow cavalry to pass ought not to be deeper than 4 feet, and for infantry not more than 3 feet.

What ought to be attended to with respect to springs and wells?

In reconnoitering springs and wells, attention must be paid to the quality and quantity of the water, also remark their situation whether they can be protected, and the enemy prevented from cutting them off.

What ought to be observed in reconnoitering forests?

Remark whether the Trees are high or low, whether there is any copse or brushwood, or whether the wood affords means of intrenching: of making fascines, abattis, &c.

What is to be observed in reconnoitering rivers?

Remark in what country they rise and where they empty themselves, the nature of the Country they run through. Learn the extent to which they are navigable; whether they freeze over; whether they are fordable at any point, and the state of their banks; whether they are capable of being defended. Remark also if their are any bridges which cross them, notice their construction, also the quality of the water, its course breadth, depth, currents.

What ought to be remarked in reconnoitering passes?

In reconnoitering passes observe their breadth, length, and situation, in what manner they can be defended and how many men it would require to do so.

What is to be noticed in reconnoitering Bridges?

In reconnoitering Bridges remark their situation length and breadth, of what materials they are constructed and whether they are strong enough to let Artillery pass over them.

WHAT is to be remarked with respect to coasts?

In reconnoitering coasts, observe, their nature, whether they are surrounded by rocks or shoals, whether there are any promontories fit for the construction of Batteries to defend the harbours. Remark what winds are required for going in and out of these harbours, the size of the harbours; depth of Water. If the coast is fortified remark the fortresses established for its defence and ascertain the defence the inhabitants are capable of making.

WHAT ought to be observed in reconnoitering a Fort?

In reconnoitering a Fort, remark, its form, whether it is ancient or modern, permanent or temporary, whether it is elevated or low; revetted or demirevetted with stone, brick, or turf, observe whether the ditch is wet or dry also, particularly remark the face of the adjacent country.

WHAT is the great object to be attended to in choosing a Military position?

In choosing a Military position there are four principal points to be attended to viz. First the advantages of the ground, the supplies for the Army, the objects to be attained, and the communications with the rear.

WHAT is another great and principal point to be observed in choosing positions?

In choosing Military positions care must be taken that it is not commanded in any part either in front, flank, or rear.

WHICH is the best nature of ground for the front of a position?

The front of a position should be intersected by rivers, ravines or broken ground, or any other obstacles that can impede the approach of an enemy; these obstacles however must not prevent the Army from being able to advance to the attack if necessary and it is an invariable rule, that all obstacles which cover a posi-

tion should be within range of the Artillery.

WHAT other points ought to be observed in the choice of positions?

In chosing a position attention must be paid that the Army can secure its retreat if necessary, and the number of passes by which it is to retreat should be carefully secured, and they should never be less than five or six.

ARE there any other requisites to be taken notice of in choosing a position?

Care ought to be taken that there is always a plentiful supply of wood and water, and the rivers, brooks &c. which supply these must be in front of the position, otherwise they will be liable to be cut off by the enemy.

WHAT is the length of an English mile?

An English mile consists of 1760 yards.

How does the length of miles differ in different parts of the World?

In Germany for instance, the long geographical mile is 10,126 yards, in France the astronomical league is 4,860 yards; in Italy it is 2,025 yards; in Russia a verst is 1,167 yards; in China a lis is 629 yards; and in Turkey, a berri is equal to 1,826 yards.

TRENCHES.

WHAT is understood by the word Trenches?

The word trenches is a general term for all the approaches at the siege of a fortified place.

How are the approaches at a siege generally carried on?

The approaches at a siege are generally carried on upon the capitals of the works attacked, because these points are of all others least exposed to the fire of either cannon or musketry.

WHAT is meant by the zigzags?

The zigzags or trenches of communication are embankments about 3 feet deep, and 10 or 12 feet wide with a berm of one foot around them.

WHAT is meant by the parallels or places of arms in the Trenches?

The parallels or places of arms are also embankments about 3 feet deep, and from 12 to 18 feet wide, having a banquette of about 3 feet wide.

IN what length of time ought the first parallel at a siege to be completed?

With a proper degree of exertion on the part of the Workmen employed, the first parallel ought to be finished the first night; at least the trenches are generally carried on as far as this work.

WITH what Tools are the workmen in the Trenches generally provided, and how much ground has each man to dig?

The workmen in the trenches are provided with a Pick Axe and shovel; they have likewise each a facine of 6 feet long, and as these fascines are laid in such a manner as to overlap each other; each man has 5 feet of trench to dig.

WHAT is the usual method of marking out the plan of attack?

The usual method of marking out the plan of attack, is by observing during the day some near object in a line with the salient parts of the works, and which may serve as a direction in the night, or if the night is not very dark, the angles of the works may be seen above the horizon.

AT what distance is the first parallel generally constructed?

The first parallel is generally constructed about 600 yards from the place attacked, and it must be made of such an extent as to embrace the prolongation of all the faces of the works which fire upon the trenches.

WHERE is the second parallel generally constructed?

The second parallel is constructed at the distance of 300 yards from the salient angles of the covert way and it is made of the same extent as the first parallel.

OF what materials is the second parallel generally constructed?

The second parallel is generally constructed of Gabions.

In what manner are the trenches usually carried on after the second parallel is constructed ?

After the second parallell has been constructed the trenches are usually carried on by sap.

Where are the half parallels constructed ?

The half parrallels are constructed about 140 or 150 yards from the covert way, and extend on each side sufficient to embrace the prolongation of all the branches of the covert way.

Where is the third parallel constructed?

The third parallel is constructed at the foot of the glacis, and it must not be nearer, otherwise it would mask the other two parallels.

How is the third parallel usually constructed ?

The third parallel is usually constructed wider than the other two parallels.

Upon what principle are Camps generally laid out in the British Service ?

In the British Service the general principle is that there should not be more ground occupied by the Camp of a body of men in front than the extent of their line when drawn out in order of battle.

What intervals are generally left between Battalions of Infantry in laying out Camps ?

Intervals of $\frac{1}{8}$ of their front are generally left between Battalions of Infantry.

In what manner is an army generally encamped ?

An Army is generally encamped in two lines and sometimes in three, the distance between the lines varying according to the nature of the country from 200 to 600 yards or more.

How many feet are allowed in a Camp for every file of men!

Two feet are generally allowed for each file of Infantry, and three feet for each file of Cavalry.

In what manner are the tents usually arranged ?

When the ground will admit of it the Tents for both services are arranged in double rows perpendicular to

the front; each row containing the tents of one Troop or Company.

WHAT quantity of ground will a Company occupy?

If the men are in bell tents, 15 feet must be allowed for a single row and 30 for a double row in front.

OF what breadth are the streets of a Camp usually made?

The streets of a camp are usuallly made $59\frac{1}{2}$ feet broad for Infantry, 30 feet for Cavalry, and 46 feet for the Horses.

WHERE is the quarter guard of a Camp generally placed?

The quarter guard is generally placed about 60 yards in front of the camp reckoning from the line of parade.

WHERE are the officers tents placed?

The subalterns tents are placed about 15 yards in rear of the mens tents, the Captains about 15 yards farther back; and the Field Officers 10 yards more in the rear.

WHAT is the total depth generally required for a Camp containing one Battalion?

The total depth of ground required to encamp one Battalion will be about 253 yards.

WHEN Guns are attached to a Battalion where are they usually placed?

When Guns are attached to a Battalion, they are placed about 4 yards to the right of the Battalion, and 15 or 18 feet is allowed for each gun.

FIELD WORKS.

In constructing field works should any particular figure be observed?

The spot on which field works are to be constructed should determine their figure nor should any attention be paid to a regular form which does not occupy the ground to advantage.

In constructing field works what should be observed with respect to the fire from Musketry?

In constructing Field works attention should be paid that every line be so disposed that the whole of the slopes are open to the small arms of the Garrison and every part should be seen to the distance of at least 500 yards.

At what distance should works be thrown up for the defence of a defile?

Works for the defence of a defile should always be within Musket shot of it, which must not be more than 200 yards.

Which is the best defence in a flanked work?

The best defence in a flanked work is that which is formed by right angles.

What ought to be observed respecting the different angles?

In constructing field works the salient angles should never be less than 60° ; nor the re-entering angles less than 90°, nor greater than 120°.

In constructing works where should the entrance to them be made?

The entrance to them should always be made in the part least exposed to attack and if possible in a re-entering angle.

What should be particularly attended to in choosing ground for works?

In choosing ground for works, all ground commanded by an eminence either in front, flank, or rear should be avoided?

What should be observed respecting the rear of works?

The rear of a work should never be left so exposed that the Enemy may turn it.

In what position

The angles of a work should always

should the angles of a work be placed? — be placed in the direction least exposed to attack, and consequently a front should always be presented to the part most exposed.

In what manner should Troops be drawn up behind a work? — The garrison should never be drawn up more than two deep, too feet being allowed for each file.

What space is usually allotted for each Gun? — From six to eight paces is usually allowed for each gun.

What number of Troops should be kept in reserve? — If a work is so large as to be defended by a battalion or two, a reserve should be allowed of about one-sixth of the number.

Of what thickness ought a parapet to resist cannon shot to be made? — In the construction of field works a parapet to resist cannon shot if it is made of earth should not be less than 12 feet thick and 8 or 9 feet in masonry.

How thick should a parapet to resist musket shot be made? — A parapet of earth to resist musket shot should not be less than 6 feet thick, or 2 feet in masonry.

How should the height of a parapet be regulated? — The height of the parapet must be regulated by the situation of the work and of the adjoining ground but with this consideration that its height above the banquette does not exceed $4\frac{1}{2}$ feet.

How ought the breadth and depth of the ditch to be regulated? — The breadth and depth of the ditch must be regulated by the quantity of earth required for the parapet and banquette.

What is a Tête-de-pont? — A Tête-de-pont is a work thrown up to cover the embarkation of Troops or the passage of a river.

What precaution ought to be taken in — In constructing tête-de-ponts care should be taken that they are always

constructing tete-de-ponts?

placed where the line of the river or coast forms a kind of re-entering angle; that the flanks of the Corps as well as those of the works may be covered.

In carrying on field works how are the different workmen generally disposed?

In carrying on Field works, when the ditches are broad the workmen are placed in two rows but if they are narrow then only in one row. The workmen in the ditch throw up the earth to others working on the parapet who spread it out and beat it down.

At what distance should the workmen be placed from each other?

The workmen should never be placed nearer than 2 paces, or 4 feet from each other, and two men with shovels should be preceded by one with a pick axe.

How should the men be disposed in carrying on the Fascine work?

In fixing the fascines, three men will be sufficient for every 24 feet of work, and they should be provided with two mallets, a saw, a hand bill, and a hatchet.

How is the given time computed in which a Field work may be thrown up?

In calculating the time for any field work to be thrown up, first compute the number of cubic feet to be excavated thus; multiply the sum of the breadth of the ditch at top and bottom; by the depth for the number of square feet in the profile; and this multiplied by the distance between the workmen in feet, will give the number of cubic feet each man has to dig.

How many cubic feet of earth will one man dig in a day?

During the summer one man is supposed to be able to remove 216 cubic feet in a day.

How soon may a common field work

A field work may be completed in 24 hours, and this time is generally

be completed with diligence on the part of the workmen? — allowed for the formation of a weak profile.

IN what length of time may stronger sorts of field works be thrown up? — When a field work is tolerably strong and revetted with fascines 48 hours are allowed to complete it, and 72 hours for the strongest.

MISCELLANEOUS.

What is the weight of a set of harness for two wheel horses?

A set of harness for a pair of horses, such as is used in the service of the Artillery, weighs about 1 cwt.

What is the weight of a common hand-barrow?

A common hand-barrow weighs about 13lbs.

What proportion is there between the strength of a Horse and that of a Man?

A Horse is generally supposed to be equal to five men.

What is the weight of a common hand-spike?

A common handspike weighs about 11lbs.

What length is the French toise?

The French toise is 6 English feet in length.

How are French feet subdivided?

Each French foot is divided into 12 inches; each inch into 12 lines; and each line into 12 points.

How many feet of water will a Ship of War of 110 Guns draw?

A Ship of War carrying 110 Guns will draw about 24 feet of water.

How much water will a 74 Gun Ship draw?

A 74 Gun Ship will draw about 18 feet of water.

How much water will a 36 gun Frigate draw?

A 36 Gun Frigate will draw about 16 feet of water.

How much water will an 18 gun Brig draw?

An 18 Gun Brig will draw about 13 feet of water.

What nature of Guns does a bomb Vessel in the British Service carry?

A bomb Vessel in the British Service carries two 10 inch Mortars, four 68 pounder Carronades, and six 18 pounder Carronades.

At what angles of elevation should the Mortars be fired?

The Mortars on board of a bomb Vessel may be fired at as low an angle as 20° though these Mortars are not intended to be used at sea but on very particular occasions, their principal intention, at these low angles being to cover the landing of Troops, and protect our coasts and harbours.

What is the greatest charge of powder used for Mortars on board of bomb Vessels?

The greatest charge of powder used for Mortars, on board of bomb Vessels is 5lb. at low angles of elevation.

How many Men are required to man a piece of Ordnance?

The following Table shews the number required for a Gun or Howitzer, as also the method of distributing the duties among a smaller number of Men.

No. of Men.	Nature.	Numbers retained.									The vacancies, how supplied.
9	Gun or Howitzer	2	3	4	5	1	6	7	8	9	Complete.
8	Gun or Howitzer	2	3	4	5	1	7	8	9		No. 6 being dropt, No. 1 does his duties.
7	Gun	2	3	4	5	1	7	9			No. 8, pouch is laid on the ground, 7 carries it when moving.
	Howitzer	2	3	4	5	1	8	9			No. 3 serves himself with cartridges.
6	Gun or Howitzer	2	3	4	1	7	9				No. 7 serves the vent with his left hand, faces about and fires—Tube box on left side.
5	Gun or Howitzer	2	3	1	7	9					No. 1 does all the duties of 4 as in the last change, his own duties, and those of 6
4	Gun or Howitzer	2	3	1	9						No. 3 fetches his own Ammunition. No. 2 serves his own Shells.
3	Gun or Howitzer	2	1	9							No. 2 serves and loads all the Ammunition. Nos. 2 and 9 must change duties occasionally.

WHAT is a graze?

A graze means the distance a shot proceeds without touching the earth; where it first touches, it is called the first graze, and so on.

The following table shows the first Graze with Field Guns.

Elevation.	12 Pr., 9 Pr. and long 6 Pr.	Light 6 Pr	Howitzers Heavy and Light 5½ Inch.	
P B......	300 yards	200 yards	P B......	150yards
¼	400	300	1 degree	300
½	500	400	2	450
¾	600	500	3	600
1 degree	700	600	4	750
1¼	775	650	5	850
1½	850	700	6	950
1¾	925	750	7	1050
2 degrees	1000	800	8	1150
2¼	1050	850	9	1200
2½	1100	900	10	1250
2¾	1150	950	11	1300
3 degrees	1200	1000	12	1350

This Table cannot be depended on as being very correct, as the strength of the powder is not given; but may be sufficiently so, for general purposes.

WHAT is the usual method adopted for calculating the tonnage of any vessel?

The usual method is to multiply the length of the keel by the breadth of the beam, and that product by half the breadth of the beam, and divide the last product by 94, and the quotient will be the tonnage.

AT what rate does sound fly?

Sound flies ar the rate of 1142 feet per second, or about 13 miles per minute.

Is water a good conductor of sound?

Water is one of the greatest conductors of sound, and it can be heard

	nearly twice as far by water as by land.
How is the distance of a Gun ascertained, the report of it being heard 6 seconds after the appearance of the flash ?	The product of 1142 by 6 will be the distance in feet.
How many feet does a heavy body fall from a state of rest, in the first second of time ?	$16\frac{1}{2}$ feet.
The number of seconds a heavy body takes to fall from a state of rest being given, how is the space descended to be ascertained ?	By multiplying twice the number of seconds minus 1 by $16\frac{1}{12}$ and the product will be the space described in feet.
How is the time found a heavy body is falling a given height ?	By dividing the given height in feet by $16\frac{1}{12}$ and the square root of that quotient will be the time in seconds.
What angle of elevation gives the greatest range on a horizontal plane ?	That of 45 degrees.
In what proportion to each other are the ranges, at angles equally above and below 45 degrees ?	They are equal, each to each respectively.
In what proportion will the range of a body be, if projected with an angle of 15 degrees, to that projected with the same force at 45 degrees ?	As 1 to 2 ; that is, the range with an angle of 15 degrees, will be half that of 45 degrees.

WHAT is the range of a body equal to, when projected with an angle of 45 degrees?

To the square of the time of its flight, expressed in seconds, multiplied by $16\frac{1}{12}$ feet.

WHAT will be the horizontal ranges of a body being projected with the same force but with different angles of elevation?

They will be as the sines of angles, double those of the elevations respectively.

IN what proportion to each other are the times of flight of the same body projected with the same force, with different angles of elevation?

They are to each other as the sines of the angles of elevation.

How is the altitude found of the curve described by a projectile at any angle of elevation?

By the following proportion; as radius is to tangent of the angle of elevation, so is the range divided by 4 to the attitude.

WHAT is the difference between tonnage by weight and that by measurement?

In tonnage by weight, 20 cwt. make 1 ton, in tonnage by measurement, 40 cubic feet equal 1 ton.

WHAT is the best kind of grease for wheels?

The composition used for greasing wheels in the Artillery Service, is composed of equal parts of tallow and the coarser kind of sweet oil melted together, and made up in kegs of 28 lbs. each. In warm climates it will require a greater proportion of the former ingredient.

WHAT are fascines, and their use?

They are composed of branches, made up in the form of faggots, of 6

feet long and 8 inches in diameter tied in two or three places. They are used for retaining the earth of parapets.

What are gabions, and their use?

They are cylindrical baskets, without a bottom, from 3 to 4 feet high, and the same in diameter, filled with earth. They are used for intrenchments in the defence of places.

What are sand bags, and their use?

Bags filled with earth, to make batteries on rocks when soil cannot be had, they are about 27 inches long and 15 in diameter.

What do you call scizing line?

Common lashing line.

To what part of a carriage is the trace chain attached?

To the gun axle-tree, formerly it was attached to the limber axle-tree, but by removing it behind the greater part of the weight, the draft is considerably less.

Is a trace chain all in one piece, or, has each pair of bullocks a separate one?

In heavy ordnance the chain is in one length, in light ordnance, each pair of bullocks has its own, length 8 feet, weight about 18lbs.

In case a trace chain breaks on the line of march, how is it repaired?

With each carriage several double iron hooks are carried, called *esses* from their shape resembling that letter, one of these connects the broken part of the chain.

What is a locking chain and its use?

The chain used to lock the wheel of a carriage, going down hill, one should be attached to each carriage, they are also of use in limbering up a piece, when any accident has happened to the pintle or pintle eye.

What is a linking chain and its use?

The small chain attached to the pole of Horse Artillery Carriages hooked to the collars of the wheel horses.

In case of any accident happening to the pole-bar, it prevents the pole falling to the ground, and also prevents the horses heads from having too much play.

WHAT is a roller, and its use?

A roller is a wooden cylinder about $1\frac{1}{2}$ or 2 feet in diameter, a little broader than the hind wheels of a transport carriage. Its use is to prevent a carriage running back when halting, (going up hill,) it is placed close behind the wheel with a chain at each end, one secures it to the drag-washer, and the other to the trace hook behind the axle-tree.

WHAT is a drag-rope and its use?

Drag-ropes are usually made of 3 inch rope, about 16 feet long, with handles that pass through it at different distances for men to lay hold of to drag; to prevent them wearing away at the end which hooks to the weight to be dragged, there is generally a short chain.

Drag-ropes are always carried with gun carriages, and are hooked to the gun limber wheel washer when the road is so bad, or, there are obstacles the cattle cannot drag the gun over, at these the men assist—they are hooked to any part, where assistance is required.

WHAT do you call a trail handspike?

The handspike by which a gun is traversed to the right or left: when the gun is limbered up it is laid on the trail, when unlimbered for action, turned round for the man who points the piece to lay hold of.

WHAT is a linch pin?

The pin that passes through the end of the axle-tree arm, to keep the wheel from coming off.

How many cartridge bags will a piece of serge make?	A piece of serge 62 yards long, and 36 inches wide will make, 9 Pounder............425 6 ,, ...500 24 ,, Howitzer...350 12 ,, ,, ...415
What is a quoin and its use?	A quoin is a wooden inclined plane, formerly used to elevate heavy guns, placed under the breech on the centre transom; elevating screws have almost superseded their use; with Mortars they are still used (elevating screws not being in general use with them) placed under the muzzle or, centre of the piece, resting on the front transom.
What do you call a chain shot?	Two common shot joined by a chain from 2 to 4 feet long, they are generally used on board ship, and are very destructive in destroying rigging.
What do you call bar shot?	Two half shot joined by an iron bar about a foot in length, they are peculiar to the Navy, and are used for the same purpose as chain shot.
What is meant by langrel or langrage shot?	When a gun is loaded with old iron nails, pieces of iron, balls and all kinds of things of this description at hand; formerly langrage was much used particularly by small craft at Sea, but is now obsolete, except in the total want of any other kind of shot.
What do you understand by the term parbuckling?	Parbuckle means to raise a weight, or mount a Mortar on its bed, without any machine; by fastening a rope or ropes to a picket, the bed of a Mortar or any thing else that will not give, and then lower the ends so

as to pass under the weight, to be raised, and bring them up over it, to where the people are standing to raise it, at these ends the power is applied and the weight raised.

A heavy gun could not be mounted in this manner, its carriage would not stand steady.

INDEX.

		Page.
ALTITUDE.	Of the curve of a projectile, how found	259
AMMUNITION.	Quantity for each piece of ordnance, in garrison	13
	Quantity for each piece of ordnance, at a siege ..	20
	How conveyed on field service	77
	Fixed, and unfixed	77
	For guns, mortars, and howitzers field service at Madras	79
	Do. in the British Army.	83
	Proportion of, for heavy and light field	after 84
ARMY.	In order of Battle, what considered, ..	1
ARTILLERY.	Personnel of, ...	1
	Component parts, of	1
	Field batteries, of	2
	Do. , how armed	2
	Do. , calibres of	3
	Advantage of mixing calibres, in field batteries	3
	Number of, for a field battery	3
	One gun never detached by itself	3
	Horse, proper pace to manœuvre at, ...	4
	Light field, meaning of	5
	Materiel of	5
	How divided	5
	Proportion of, to armies	8
	When charged by cavalry, how placed	7
	How placed, with regard to infantry	169
	How used in an advance	9
	Do. in defence	9
	Do. in passing a river, ...	9
	Do. Do. a defile	9
	How posted in a defensive position	9
	How posted in an offensive position	10
	Proportion of, to a division of 12,000 Men	10
	Proportion of, in a park	11
	Choosing positions for	11
	Different natures of, in Garrison	12
	How arranged in defence of a hexagon	14
	Quantity required for the siege of a fortified place,	19

		Page.
ARTILLERY.	Arrangement of, at a siege, ...	20
	Best position of, to destroy the face of a work	20
	Best position of, to destroy the defences of a place	21
	Breach, made by	21
AXLETREES.	Objections against iron	62
	Not taken off, when carriages are embarked	196
BALLS.	Iron, size of, for case shot, ...	103
	Light, description of and use, ...	118
	Do. composition for	118
	Do. table of, cases for	118
	Lead, quantity required in a fortified place	13
	To find the weight of, lead	98
	Musket, 14 to the lb.	13
BARRELS.	Manner of piling, in a magazine	24
	Powder contained in	28
	Marks on	29
BASKET BOATS.	Shape of	241
	How used	241
	Size of	243
BATTERIES.	Description of	157
	Dimensions of	157
	For Mortars	158
	Enfilading	159
	Most advantageous height for placing, Sea	159
	Howitzer, how constructed	160
	Do. where constructed, at a siege	22
	Barbette	160
	Sunken	161
	Raised	161
	Number required before a fortified place	19
	Breaching, where placed at a siege	21
	Precautions to be taken in constructing	21
	Principal object, in constructing	23
BEDS MORTAR.	Proof of	72
	Construction of	72
	Dimensions of	72
BOMB VESSEL.	....	256
BOTTOMS.	For cannister shot	102
BREACH.	How to be stopped up	18
	When assaulted, expedients to be adopted	18
	Manner of making, by Artillery	21

		Page.
	Length should be made	22
	Time for making	22
BRIDGES.	How destroyed	180
BULLOCKS.	How much one will carry	201
	do. will two draw	201
	Proportion of to carriages	201
	Madras Table of	203
	Bombay table of	205
	Bengal, table of	207
	How yoked to Carriages	201
	Drivers position of	202
CALIBRE.	Of Guns	44
	Length of Guns ascertained in	43
CAMPS.	Nature of	249
CALCULATION.	How many cubic feet of soil a man will dig in a day	253
CAMELS.	How used	202
	Weight one will carry	202
CANNISTER SHOT.	Description of	102
	Iron bottoms for	102
	Table of	105
	Service required for	103
	Distance to be fired	103
CARCASSES.	Description, and use of	116
	Composition for	116
	Dimensions, table of	117
CARRONADES.	Description of	53
	Service intended for	53
	Dimensions, table of	54
	How denominated	37
CARRIAGES.	Gun, proof of	55
	do. battering train	55
	do. weight of	59
	Gun, field do.	60
	Gun, field weight of	63
	Howitzer, proof of	68
	do. weight of	69
	Transport	56
	do. how used	56
	do. weight of	59
	Difference of weight, Madras and English	59
	Description of, Beam Trail	60

		Page.
CARRIAGES.	Description new construction Madras	61
	Difference between Howitzer and Gun	68
	How placed when embarked	197
CARTRIDGES.	Small arms	92
	Difference of paper, why blue and white	92
	Madras table of, for small arms	94
	English do.	95
	For ordnance, what made of	78
	Why not fixed to shot	78
	How carried with field ordnance	78
	How put into the Piece	79
	Number made from a piece of serge	262
	Why not used for Mortars	172
	Colored serge, why preferable to white	78
CASE SHOT.	Vide "Cannister and Spherical."	
CATTLE.	What description, used with Artillery	200
CENTRE.	Of a piece of Ordnance, meaning of and use	135
CHAIN.	Trace, what part of a Carriage attached to	260
	Linking, use of	260
	Locking, use of	260
CHARGE.	Of powder, weight of for pieces of Ordnance	88
	Disadvantages of, large	88
	Larger used for Iron guns, than for brass	88
	Reduction of, according to strength of powder	88
	How calculated for Mortars	89
	Table of, English	90
	do. Madras	91
	For the first, second and third periods of a siege....	20
	For bursting shells	91
	For ricochet firing	20
	In a mine	177
	For proving Guns	38
COMMANDANT.	Of a fortified place, precautions taken by him	16
COMPASSES CALIBRE	Description of	145
	How used	145
	Angle of elevation, how taken with	146
	For measuring a shell s bottom	147
	For measuring a shell s side	148
COMPOSITION.	Fuze and port-fire, of what made	119
	Ingredients, proportion of	119
	Mixing, process of	119
	Rocket, of what made	120

		Page.
COMPOSITION.	Rocket, proportion of	120
	Table, of	120
	Time, will keep good	120
COPPER.	Use of, in gun metal	43
	Bouches made of	199
DEFENCE.	Best in a flanked work	251
DISEMBARKING.	Ordnance	198
DISPART.	Explanation of	35
DISTANCES.	Are either accessible, or inaccessible	208
	Ascertained by two pickets	213
	do. by the tangent scale of a gun	214
	Between two inaccessible objects how taken	216
	Instruments in use, for taking	217
	Angles subtended by a Foot, at different	219
	How found, when an object first comes in sight	217
DITCH.	Breadth and depth of, a Field Work	252
DRAG ROPE.	Description, and use	261
DRIVER FUZE.	Use, and description of	151
ELEPHANTS.	How used	202
	How much, one will carry	202
ELEVATION.	Meaning of	183
	Angle of, gives the greatest range	258
	Angle of, equally above 45 deg.	258
	Necessity of elevation	176
EMBARKING.	Ordnance and stores	195
	How stowed when transported from one place to another	195
	For an expedition, how stowed	195
	Ordnance and stores, how marked	196
EXERCISE.	Of ordnance, number of men required	256
FASCINES.	Description, and use	254
	Disposition of men, in fixing	253
FEET FRENCH.	How subdivided	255
FIELD WORKS.	Construction of	251
	Distance to be thrown up	251
	Entrance to, where made	251
	Disposition of the workmen	252
	Calculation of the time, in which they may be thrown up	253

		Page.
FLIGHT.	Of a shell, how taken	186
FLINTS.	Number of in a Garrison	13
FORTIFIED PLACES.	How divided	12
	Number of Ordnance for	12
	Artillery required for the siege of	19
FUZE.	Composition for	119
	Description of, and use	124
	Circles on the exterior, use of	125
	Difference between common, and S. C. S, ...	125
	Time of burning	126
	How set in a shell	151
	Method of driving	126
	Table of	128
FUZE AUGER.	Use of	150
	Difference between brace, and hand	151
FUZE ENGINE.	Use of	153
„ PINCERS.	How used	153
GABIONS.	Description, and use	260
GIN.	Description, and use	229
	Dimensions	229
	Time in mounting and dismounting an 18 Pdr. Iron	229
GRAPE.	Description of	104
GRAVITY.	Meaning of the term	222
	Table of, specific	222
	Finding the weights of bodies by	224
	Force of	224
	Centre of	226
	do. how found	226
GRAZE.	Meaning of the term	257
	Table of	257
GREASE.	Best kind for wheels	259
GUNS.	Shape of	42
	Metal for, of what composed	42
	Natures of	43
	Proportion between shot, and	43
	Mounting, and dismounting	57
	Table of, brass	44
	„ „ iron	45
	General table	45
	How denominated	37

		Page.
GUNS.	Proof of	38
	When abandoned, what steps are taken	170
GUNPOWDER.	Ingredients of	25
	Expansive force of	25
	Elastic fluid, how generated	26
	Size of grain	26
GUNPOWDER.	Glazing	27
	Cylinder, meaning of	28
	Pit, meaning of	28
	How carried on service	28
	Proof of, ...	30
	When injured, not totally lost	33
	Quantity to fill a rectangular box, ...	33
	,, ,, ,, cylinder	33
	,, to blow up a cubic fathom of earth	33
	In a cubic foot	34
HAND BARROW.	Weight of	255
HANDSPIKE.	Weight of	255
	Description, and use	261
HARNESS.	Weight of one sett	255
HEIGHTS.	Considered either accessible or inaccessible	208
	Are taken by the shadow of an object, ...	209
	Taken by 2 staves of unequal length, ...	210
	,, ,, square and plummet	211
	,, ,, barometer and thermometer	212
HORSES.	Not generally used in India	200
	Proportion of weight, one will draw	200
	Team of, will draw	200
	Rate, will walk, trot or gallop	200
	Proportion of, for field artillery	200
	Allowance of, to field artillery	201
	A pair, abreast will draw	201
HOWITZER.	How distinguished from a Gun	50
	Advantages of, over other pieces	50
	Can be used as a mortar	50
	New description of, established	51
	Iron 10 and 8 Inch, for what purpose intended	51
	Brass 24 and 12 pounders, advantages of	51
	Medium 5½ Inch	52
	Light 5½ Inch, obsolete	52

		Page.
HOWITZER.	Table of,	51
	Objections to short	52
	Proportion of, in Garrison	13
	do. of, for a Siege	19
	How denominated,	37
	Proof of,	39
INSTRUMENTS.	In use with artillery	134
JACK.	Description, and use	230
LABORATORY.	Meaning of the term	119
LEVELLING.	Difference, true and apparent	220
	do. how found	220
LINE.	Seizing, name of	260
	Of metal, use of	134
LINCH PIN.	Description, and use	261
MAGAZINE.	Permanent, construction of	23
	Formation of the roof,	23
	Sides, how supported	23
	Windows, how secured	24
	Floor of, precautions	24
	Quantity of powder contained in	24
	Powder how piled in	24
	Temporary, construction of	160
	do. , dimensions of	160
	do. , small why preferred	160
MATCH.	Quick, making, process of	132
	do. , how composed, and its use	132
	Slow, description and use	133
	Quick why used, for priming mortars	172
MECHANICAL POWERS.	Description of,	231
	Lever, natures of	231
	do. power of, how calculated	232
	Wheel and axle, power of	233
	do. do do. how calculated	234
	Pulley, power of,	234
	Plane, inclined, nature of	235
	Wedge, power of	236
	Screw, power of	236
	Funicular, nature of	237

		Page.
MILES.	Length of, English, and others	247
MINES.	Description, and use	177
	Charge for, and table	177
	Chamber of, best shape	179
	Branches of, how stopped	179
	How made to destroy a stone bridge	180
	Workmen in, how far heard	180
	Blowing up of, excavation formed	180
MORTARS.	Proof of, ...	39
	How denominated	37
	How distinguished from a Gun	46
	Why made with chambers	46
	Chamber of, shape	46
	Trunnions of, why at the breech	47
	Why not mounted on wheel carriages	47
	Stone, when used	48
	Table of	49
	Proportion of, to a Garrison	13
	do do, at a Siege	19
	Batteries how made	159
	Beds, ...	72
	Why fired at 45°	173
	Why primed with quick match	172
	Cartridges, why not used with	172
MUSKETS	Number of in a garrison	13
MUSKETRY.	At what period of a siege, brought into play	17
MULE.	Weight, carried by	201
	do can draw	201
NAVES.	Brass, advantages of	61
ORDNANCE.	How distinguished	35
	How rendered unfit for service	36
	Metals made of	36
	Advantages of brass, over iron	36
	Natures of, in common use	36
	Value of, iron, and brass	37
	Proof of, do. do.	38
	Marks put on	40
	Preservation of	40
PARALLELS.	First, how constructed	248

		Page.
PARALLELS.	Second, do.	243
	Third, do	249
	Half, where constructed	249
PARAPET.	To resist cannon, thickness of	252
	To resist musketry,	252
	Height of	252
PARBUCKLING.	Method of getting a Gun into a Boat by,	
	Meaning of the term	262
PENDULUM.	Use of an Artillery	188
	Length of, for seconds	188
	How measured	188
	Length, for different paces	188
	Ballastic, use of	188
	Table of,	188
	Length of, to find for different vibrations	189
PERPENDICULAR.	Description and use	134
	How used	134
	Correct, how to find out	135
	How adjusted	137
PLATFORM.	Different kinds, mortar	162
	Fixed, mortar	162
	Traversing, mortar	162
	Gun, traversing	163
	do dove tailed	164
	Which kind best	165
	Slope of.	165
POINT BLANK.	Meaning of,	36
POLE BAR.	Use of,	67
POLE STRAP.	Use of,	67
PONTOONS.	Materials made of	238
	Dimensions,	238
	How placed	238
	How laid, and number of Men	238
	Precautions necessary,	238
	Precautions necessary when troops and carriages pass	239
	Situations for	239
	Not procurable, what to be done	240
PORTFIRES.	Composition for	119
	Use of	121
	How drove, or filled	121
	Time, of burning	122

		Page.
PORTFIRES.	Table of	123
	Objections to their use	123
POSITION.	Military, choice of, ...	216
PRACTICE.	Meaning of	167
	Heavy guns in Battery	167
	First direction of the fire	167
	Firing during the night	168
	Field guns, precautions necessary	169
	do. how distributed	169
	Howitzers, ...	170
	Mortars how placed in battery	171
	Steps next taken	171
PROJECTILES.	Nature of	96
QUADRANT.	Description and use	138
	Which best, spirit or plummet	138
	How applied	138
	How adjusted	139
QUADRATING.	Meaning of	55
QUARTER SIGHTS.	Description and use of	141
QUOIN.	Description and use	262
RANGES.	Meaning of the term	36
	Greatest, angle that gives	258
	Proportion of, at angles equally above and below 45°	258
	With different angles, ...	259
RECOIL.	Meaning of the word	186
	Cause, and effects of	186
	How far guns generally recoil	186
	Not as much in mortars, as in guns	187
RECONNOITERING.	Precautions to be taken in	244
	Principal points to be attended to	244
	Best sketch book	244
	Roads, what to be attended to	244
	Rivers, ...	245
	Bridges and coasts	245
	Forts	246
RED HOT SHOT.	Precautions in loading	99
	Expands, when heated	99
	How carried	99
	How loaded	99

		Page.
RED HOT SHOT.	Why are colored serge cartridges used	78
RICOCHET FIRING.	Meaning of the term	174
	Object of	174
	Angles, best calculated for	175
	Guns for, how placed in battery	175
	Elevation, usually given	175
RIVERS.	Mode of crossing, in India	241
	Other means of crossing	243
ROLLER.	Description and use	261
ROPES.	How distinguished	190
	Weight of, how found	190
	Strength of, how ascertained	190
	Best tar, for	190
	Goodness of, how judged	190
	Coir, description of	191
	Tables of	192
SAND BAGS.	Quantity, for a fortified place	13
	Description of, and use	260
SCALING.	Meaning of the term	35
	Powder for	89
SEARCHER.	Description and use	148
SERGE.	Number of cartridges one piece will make	262
	Different colors, why used	92
SETTER.	Description, and use of	151
SHELLS.	Description of	111
	How distinguished	111
	Purpose intended	111
	How filled	111
	When they should burst	112
	Used in breaching	113
	Proof of	113
	To find the weight of	113
	How thrown from a piece, when too large for the bore	114
	Table of weight and dimensions	115
	Proportion of, for a fortified place	13
	Do. do. do a siege	20
	How lifted into a mortar	171
SHIPS.	Their draught of water	255
	Tonnage of, how found	257
SHOT.	Different kinds of	96

		Page.
SHOT,	Metal made of	96
	Examination of, before sent on Service	96
	Mode of carrying them, on service	97
	Number in a pile, how calculated	97
	To find the weight and dimensions of	98
	Hot, when used	99
	Why made less than the bore of the piece	100
	Table of dimensions	101
	Number required for a siege	20
	Chain, description of	262
	Bar do. do.	262
	Langrel, do. do.	262
SHRAPNELLS.	Meaning of	106
SIEGE.	Artillery, required for	19
	do. how arranged at	20
SORTIE.	Best time for making	17
	In what part of the works to assemble	17
	What to be accompanied with	17
	Detachment accompanying, how posted	18
SOUND.	Velocity of	257
	Water, conductor of	257
SPACE.	A body falls, in a second of time	258
	Ascertained, a body falls in a given time	258
SPHERICAL CASE.	Description of	106
	Advantage of	107
	How filled	107
	When prepared	108
TANGENT SCALE.	Construction of, and use	141
	How applied	142
	Compared with a quadrant	142
	Use of the figures and letters marked on it	143
	Table of	141
TERTIATE.	Meaning of the term	35
TETE-DE-PONT.	Construction of	252
TIER SHOT.	Description of	109
	Table of	110
TIN.	Use of, in gun metal	42
TOISE.	Length of	255
TONNAGE.	Of a vessel, how calculated	252
	Difference of, between weight and measurement....	259

INDEX.

		Page.
TONNAGE.	Difference of, in different articles	195
TRENCHES.	Meaning of the term	247
	Tools used in	248
	How carried on, after the 2d Parallel	248
	Troops in, how protected	23
TROOPS.	In what manner drawn up behind a work	252
TUBES.	Description, and use of	150
	Which best,	150
	How filled,	150
VELOCITY.	Initial, of a projectile	183
	Not encreased, by encreased charges	183
	Greatest velocity can be given	184
	Density of the air, no effect on	185
VENTS.	Diameter of	199
	How cleared when stopped	199
	When enlarged by firing, how repaired	199
WHEELS.	Description of	74
	Field carriages	74
WINDAGE.	What is termed	181
	Necessity of	181
	Disadvantage of	181
	Table of	182
	Of French guns	182
ZIG ZAG.	Description of	247

THE TANJORE MAHARAJA SERFOJI'S SARASWATI MAHAL.